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THE

CLIMATE

OF

GREAT BRITAIN;

OR

REMARKS ON THE CHANGE IT HAS UNDERGONE, PARTICULARLY WITHIN THE LAST FIFTY YEARS.

ACCOUNTING FOR

THE INCREASING HUMIDITY AND CONSEQUENT CLOUDINESS AND COLDNESS OF OUR SPRINGS AND SUMMERS;

With the Effects such ungenial Seasons have produced upon the Vegetable and Animal Economy.

INCLUDING

VARIOUS EXPERIMENTS TO ASCERTAIN THE CAUSES OF SUCH CHANGE.

INTERSPERSED

With numerous Physiological Facts and Observations, illustrative of the Process in Vegetation, and the Connection subsisting between the Phenomena of the Weather and the Productions of the Soil.

BY JOHN WILLIAMS, ESQ.

London:
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TO

SIR JOHN SINCLAIR, BART,

PRESIDENT OF THE BOARD OF AGRICULTURE.

SIR,

THE high and distinguished Rank you have long held among Men of Science, and more especially among those who have dedicated their Science to the Benefit of their Country, is universally acknowledged.

Your being reinstated to the Presidency of a Board instituted for the purposes of ameliorating the Soil, increasing its Productions, and extending the Comforts of Society, must, to every Patriot, be a subject of high Gratification.

The little Work here placed under your Protection, and which will assure to it a candid perusal, is submitted, with the utmost deference, to the Public; and should it, in the least degree, further an Enquiry into the important Pursuits in which you and the Board are engaged, I am confident that it will meet with your Approbation, and I hope will assist, in some degree, to shew how far your Patriotism extends, and with what admiration and respect

I am, Sir,

Your obedient and obliged Servant,

J. WILLIAMS.

PREFACE.

THE Subject of the following Sheets, it will be allowed by all, is novel, and the path which leads to it as yet untrod; little progress having hitherto been made in Meteorology, the difficulties to encounter, in such an undertaking, must be consequently great: its high importance must, however, be admitted, as it not only respects the productions of the soil upon which our very existence depends, but refers also to every species of National Improvement—to the Health of Mankind—and the Comfort of Society.

The Remarks here candidly submitted to the judgment of the Public, are the result of many Years spent in making experiments for the purpose; and which have been conducted with great labour, and at considerable expence. As these have often been repeated, and the conclusions not hastily drawn, the Public may rely on their general accuracy.

The Author's preconceived views on the principal subjects here treated of, have been most satisfactorily answered by them, and his opinions confirmed. They also correspond with Experiments of a similar nature, which have been recently made by the ablest Physiologists, both on the Continent as well as in this country. Perhaps it may be objected by some, that the Theory is chimerical, and the suggestions impious; to such it may be observed, that to attempt to improve the surrounding medium in which we breathe, is equally as rational as to melioaate the surface of the ground on which we tread: if the latter is barren, we think we possess an undoubted right to fertilize it; and if the former become noxious, we surely possess an equal right to endeavour to correct it. Whatever alteration is produced on the Earth by the skill and industry of Man, furnishes an additional argument for what may hereafter be done in the Atmosphere around us. Nay, if such an objection as this were at all allowable, it would apply equally strong against what has already been accomplished; it would tend to condemn an useful Plan, long generally approved and adopted, that of *dissipating Electric Clouds by Conductors affixed to Ships and Buildings, to prevent the terrible effects otherwise produced by Lightning.* Thus viewing every Scheme for diminishing the wants, and increasing the comforts of Man as highly rational, the Author submits his Hints to the candid Investigation of a discerning Public; rather wishing to appear in the Character of an humble Enquirer, than as a dogmatising Theorist. His Aim is Truth, his Motive good; his only Wish the furtherance of Science; his Desire, to serve the Cause of Humanity—and, as he covets no Praise, he fears no Blame.

Whatever may become of the Theory here laid down, if, after a fair and mature investigation, it appear not to be *substantially founded*, in the view of candid and scientific men, he hopes, at least, to have credit given him for a set of accurate and valuable Experiments, with useful and important Observations, which may be of service to further Enquirers; and tend at least to throw some light upon a subject, hitherto buried in almost profound obscurity.

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ON THE
CLIMATE
OF
GREAT BRITAIN,
AND THE CHANGES IT HAS UNDERGONE.

CHAPTER I.

On the Climate.

TO create worlds, to arrange the different parts, to organize the whole, furnish them with inhabitants of different descriptions, and to provide supplies for their various wants, is the glorious prerogative of the blessed Creator. To collect, modify, and adopt for necessary uses, is the privilege of the creature; and chiefly, as endowed with superior powers, and delegated with superior authority, of his creature MAN. The subordinate ranks of being appear to be placed under his protection, and formed for his ultimate use. In proportion as real science advances, his powers are found less limited; the goodness of GOD appears still more visible in creation; and while the mind is expanded by discoveries, the motives for gratitude continually increase. The evils he was accustomed to look upon as inevitable, he finds are of a temporary nature, and many which he has been accustomed to lament, were within his reach to remedy; and that while he has been silently complaining against a beneficent Deity, he ought to have chided his own inattention, and condemned his own sloth. Numberless instances might be adduced; but we trust this truth will appear as strongly in the present case, as in the methods recently discovered for destroying contagion, preventing some diseases, and extirpating others. With this view we enter upon the subject, and to this end are pointed the remarks we shall make upon the changes this climate has undergone.

England, from its insular situation, in common with all other Islands must ever experience to a certain degree, a variable atmosphere: the changes of temperature with respect to heat and cold, dryness and moisture, being more frequent and sudden than in countries on the Continent. The climate of this country is universally allowed, by those who have had opportunities of making comparisons, to be the most uncertain of any on the Globe. This perhaps may be accounted for from its peculiar situation; its distance from the equatorial and polar parts of the Earth; its having the great European

Continent to the east, and an extensive ocean to the west. Notwithstanding this variableness, however, it possesses many advantages over countries situated between the same parallels of latitude on the Continent; the inhabitants not being subject to the extremes of heat and drought in summer, nor of cold and frost in winter. The greatest defects in the English climate appear to be, the dry cold easterly winds generally prevalent in the spring, and the frequent rain and cloudy skies experienced in our summer months. It has been an opinion universally adopted of late years, that the generality of our summers are more wet, and consequently colder, and our winters less frosty and more mild than they formerly were. This remark has been made not only by speculative, but practical men; by those most observant, because most affected by ungenial weather. Persons ignorant of the strong and uniform connection between cause and effect are utterly at a loss to account for it, while they acknowledge the fact; and the generality of such persons, being addicted to superstition, do not fail on such occasions to cut the knot they cannot untie, and solve every difficulty by having recourse to supernatural means;—the malice of our grand enemy, or the judgments of the Almighty. Hence while this change has been observed, the greater part of the observers have attributed it to that outrageously impious act of our legislature in the year 1752;—*for to change the style, with them, is to alter the seasons.* To this has been attributed the cloudy and ungenial weather we have more or less experienced ever since, and the years of scarcity we have so frequently felt. This change, it has been peculiarly remarked, has been taking place since about the years 1770 or 1775. And if we apply for information on this subject to people occupied in rural affairs, whose time has been employed in agricultural or horticultural pursuits, whether or not the generality of our summers have been of late years more unfavourable for the production of corn and fruit? the answer is in the affirmative; for the seasons have been invariably more wet and cold than formerly they were. But the enquiring mind on such occasions is naturally rouzed to investigation, and endeavours to account for the causes of this extraordinary and unfortunate change. We find from astronomical observation, that our geographical position on the globe has not varied materially; for though it has been ascertained that the angle formed by the equator and the ecliptic has been gradually lessening, called the nutation of the earth's axis; and the retrograde motion observed in the apparent situation of some remarkable fixed stars, called the procession of the equinoxes, proves that some alteration annually takes place; yet the ratio is so small, that the aggregate of centuries will not amount to sufficient aberration to justify us in considering this as the *sole* or *principal* cause in the mutability of our seasons. For we do not hear the same complaint of wet cold seasons from our neighbours, who inhabit the same parallels of latitude on the Continent: we may therefore with propriety suppose this increasing disposition to humidity in summer and mildness in winter*, is owing to *some change effected on the surface of our Island.* It will therefore be an useful and necessary inquiry, to ascertain what changes of this nature have occurred for a series of years back, and how far they may have been affected by human art.

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* The quantity of free thermometrical heat given out in the processes of combustion and animal respiration throughout Europe, and *Britain* in particular, probably may have some influence on the atmosphere, and cause an increase of temperature in winter. Suppose, by way of illustration, that all the various culinary fires, and others employed in our extensive manufactories, with the nocturnal combustion of oil and tallow made into one immense fire, the heat given to the circumambient atmosphere would be very considerable; the quantity of heat, therefore, given out from *this source* must be vastly greater than it was some centuries ago. The same reasoning will apply to animal respiration.

We possess no direct mean of ascertaining the variations of the weather,

> "In days of yore, when knights were cased in mail,
> "And falcon gentil entertained nobility:"—

as the *thermometer* and *barometer* are inventions of modern times. We must therefore reason from historical facts, and draw our conclusions chiefly from analogy. Judging from the account the Romans gave of the climate in Britain, France, Germany, and the other Celtic countries they invaded, there is reason to believe the climate of each experienced a considerable amelioration from an increase of population and the introduction of their system of agriculture. The extensive forests being felled, and swampy morasses drained, which previously occupied a considerable portion of this kingdom, a less vaporous atmosphere was consequently raised; and the genial influence of the solar rays being admitted to warm the soil, the acquired heat enabled it better to resist the cold of winter: and thus a milder temperature was produced. In speaking of the climate of England in modern times, it is a common remark how much more disposed to cloudiness and humidity the atmosphere must have been before the extensive forests were cleared, and the morasses drained! It probably was so; but when we say the country was overrun with wood, we can by no means suppose that every acre of surface was in this state; it could only have been so in the vale countries; for it does not appear that many of our extensive downs, which are generally in elevated and exposed situations, were ever covered with wood; as we have no accounts of their denudation, nor are there the most remote vestiges remaining of such a state. We cannot therefore imagine that Salisbury plain, the downs of Dorset, the Cotswold hills in Glocestershire, or the wolds of Yorkshire, were ever covered with extensive woods. The British aborigines, when first visited by the Romans, appear to have been but little conversant with the cultivation of the ground; for, according to the early writers, Cæsar, Strabo, Diodorus Siculus, and others, they subsisted principally on flesh and milk: but, from their intercourse with the more civilized Romans, they were soon taught to turn their attention to agriculture. At this period we may date the commencement of an improvement in the climate: the rich vales were first cleared on account of their greater depth of soil, and the decayed vegetable matter, such as leaves, moss, &c. which was deposited on the surface. This, which had been accumulating for centuries, reduced by time to excellent soil, now subjected to the plough, produced most luxuriant crops; as appears by the supplies of grain drawn from this Island for the use of the Roman armies in Britain, and their brethren at home. All the traces of Roman vineyards are now lost; but Tacitas says vineyards were introduced into Britain by the Romans and Vopiscus, (vid. in vita Probi. c. 18) says the Britons were allowed vineyards for wine "Britannis permisit ut vites haberent vinumque conficerent;" probably at first they found but few genial spots; yet as the country improved, the climate became more favourable to the culture of this valuable plant. Bede, an early writer, mentions the introduction of it by the Romans, most likely the *Roman Britons*, who, finding the climate improved, afterwards, in imitation of their southern neighbours, introduced the vine; for if this were not the case, how can we account for particular lands bearing the appellation of *vineyards*, which many do even to the present day. The vale of Glocestershire, according to William of Malmsbury, produced, in the twelfth century, as good wine as many provinces in France; and in the counties of Worcester, Hereford, Somerset, Cambridge, Kent, and Essex, lands are still to be found called by the name of vineyards. William of Malmsbury writes thus in his book De Pontificibus:—"The vale of Gloucester is so called from its chief city, the soil whereof yieldeth variety of fruits and plants, and all sorts of grain; in some places by the natural richness of the ground, and in others by the diligence of the countryman: enough to excite the idlest person to take pains, when it repays his industry with the increase of a hundred fold. Here you behold the highways and public roads full of fruit trees, not set, but growing naturally. The earth, of its own accord, bearing fruit exceeding others both in taste and beauty; many of which continue fresh the whole year round, and serve the owner till he is supplied by a new increase. There is no province in England hath so many or so good *vineyards* as this country, either for fertility or sweetness of the grape; the wine whereof carrieth no unpleasant tartness, being not much inferior to the *French in sweetness*.

"In the early periods of our history, the Isle of Ely was expressly denominated *the Isle of Vines by the Normans.*" "*Vineyards* are frequently noticed in the descriptive accounts of doomsday, and those of England are even mentioned by Bede, as early as the commencement of the eighth century. Doomsday exhibits to us a particular proof, that wine was made in England during the period preceding the conquest; and after the conquest the Bishop of Ely appears to have received at least three or four tons of wine annually, as tythes from the produce of the *Vineyards* in his diocese, *and to have made frequent reservations in his leases of a certain quantity of wine for rent.*" "A plot of land in London, which now forms East Smithfield, and some adjoining streets, was withheld from the religious house within Aldgate, by four successive constables of the tower, in the reigns of Rufus, Henry, and Stephen, and made by them into a *Vineyard* to their great emolument and profit." "In the old accounts of rectorial and vicarial revenues, and in the old registers of ecclesiastical suits concerning them, the *tythe of wine* is an article, that frequently occurs in Kent, Surry, and other counties." The church of Glastonbury has in that vill twelve hides, which were never assessed nor taxed. The arable is thirty carucates, in demesne are ten hides, wanting one virgate, and these five carucates, and seventeen servants, and twenty-one villanes, and twenty-three cottagers, with five ploughs. There are eight smiths, and *three arpents of vineyard*, and sixty acres of wood. It is worth twenty pounds.—To this manor adjoins an island, called Mere, where are sixty acres of land. The arable is one carucate, and there are ten fishermen; three fisheries, which pay twenty pence, and six acres of meadow, and six acres of wood, *and two arpents of vineyard.* It is worth twenty shillings.—Another island belongs thereto, which is called Padeneberie. There are six acres of land, and *three arpents of vineyard* and one cottage. It is worth four shillings.—*Lib. Domesday.*—In Sir Robert Atkins's History of Gloucestershire, there is an account of the tythe of wine, and *vineyards*, amongst others, granted to the abbey of Flaxley, in the forest of Dean. That the beautiful and still fruitful vale of Glamorgan once abounded *with vineyards*, and produced wine of excellent quality, appears from a manuscript of Truman, and others, preserved in the archives of the church of Llandaff. Some persons however have affected to doubt the meaning of the word *vinea*, found in ancient records, and suppose it meant not a plantation of grapes for the purpose of making wine, but an apple orchard, or currant garden!! Mr. Speechly, in his treatise on the culture of the vine, mentions a controversy which arose between the Reverend Mr. Pegg and the Honourable Daines Barrington on this subject; and as I think it is of importance towards proving the increasing humidity and cloudiness of our summers, I shall insert it.—" Mr. Pegg has informed me by letter, that Dr. Stukely, in Itin. p. 48, speaks of a vineyard near Chipping-Norton; Wm. Thorn. col. 2036. of another in Kent; and that Maddox, in his History of the Exchequer, 1. p. 364, writes that the sheriffs of Northamptonshire and Leicestershire were allowed " for the livery of the king's vine-dresser at Rockingham, and for necessaries for the vineyard." He further adds, that the late Dean of Ely, Dr. Thomas, imparted to him the following extracts from the archives of the church:

	£.	s.	d.
" Exitus vineti	2	15	3¼
Ditto vineæ	10	12	2½
Ten bushels of grapes from the vineyard	0	7	6
Seven dolia masti from the vineyard, 12 Edward II.	15	1	0
Wine sold for	1	12	0
Verjuice	1	7	0
One doliam and one pipe filled with wine, and supposed at Ely			
For wine out of this vineyard	1	2	2
For verjuice from thence	0	16	6

No wine but verjuice made 9th Ed. IV.

It appears plainly, says Mr. Pegg, from these extracts, first, that in the latitude of Ely, grapes would sometimes ripen, and the convent made wine of them, and sometimes not, and then they were converted into verjuice."

The remark that *no wine* was made in the ninth of Edward the Fourth *but verjuice*, is strongly in favour of Mr. Pegg's opinion, that they were plantations of the *vine*, and what we at present mean by *vineyards*. For we do not find, even in seasons the most unfavourable for ripening apples, that the liquor expressed from them is made into verjuice instead of cyder. I am therefore decidedly of opinion, that the word *vinea* meant a plantation of some varieties of the *vitis vinefera*, for the purpose of making wine. We do not know exactly the time when this kind of culture was abandoned, or the production of wine ceased to be an object of the farmer. Perhaps these improvements derived through the Romans, gradually disappeared among the Britons, from the perpetually harassing wars of the Saxons; and among the Saxons, from the policy of the Normans; or frequent negotiations of the French monarchs in favour of their own commercial treaties; or the passion that existed in the English court for the subjugation of France, the consequent introduction of the luxuries of that country, and the prevailing taste for the productions of it in preference to our own. These might have been auxiliary causes, but the most powerful one appears to be that which has been by most overlooked. *A succession of unfavourable seasons was probably the promoting, if not the immediate cause of a general dereliction of such a profitable kind of husbandry.* There is reason to think, that the wine made from apples and pears, called cyder and perry, is a liquor of more modern invention; for in the ancient Roman language we do not meet with *any word that means expressly such a liquor.* The moderns use a periphrasis to convey the idea; and when Camden speaks of *perry in Worcestershire,* he seems to mention it as a liquor not even then generally known. In his survey of Worcestershire he says "it produceth pears in great abundance, which, though not grateful to nice palates, nor do they keep well, yet they afford a vinous juice, of which is made a *counterfeit* wine, called *perry,* which is very much drank, though it be like other liquors of that kind, both cold and flatulent." Nor is there, previous to the time of Henry VIII. any evidence that the apple or the pear were generally cultivated. Subsequent to that period it is, that we find any account in English botanical works of these profitable trees. When the climate of this country became too precarious for the vine, the apple and the pear were cultivated as substitutes, producing a liquor whose flavour and qualities came nearer to that of wine than the national beverage long drank under the name of *beer,* the Saxon term for barley, whence it was usually extracted. Numerous trials have been made in the course of the last century to cultivate the vine again, but with unavailing success. Indeed latterly the summers have in general been so cool and cloudy that the grapes have seldom ripened properly, even with the advantage of a convenient wall and southern aspect. Admitting the authorities I have quoted to be authentic evidence, that the vine was successfully cultivated in former ages, and of the failure of such a culture in the present; it furnishes a strong proof of the increased coldness of our summers, and in a measure supplies the place of a thermometrical register of temperature in those times, enabling us to form a comparison with the present. An idea of the theory I now submit to the public, to account for this change of climate, occurred to me some years since; and a close attention to the phenomena of the weather for the last seven years, has much strengthened that idea, and tended to confirm what at first may appear a bold hypothesis. *I attribute the humidity, and consequently coldness, of our modern summers, to the increased evaporating surface, caused by the enclosing of the open fields and wastes; the multifarious intersections of them by fences, especially with hawthorn; to the increased luxuriance of our crops, by a general system of improvement in the agriculture of the country; to these I may with propriety add the late increase of pasturage, productive of a serious disproportion between that and tillage; to the numerous plantations, more especi-*

ally of foreign trees, and such whose exhaling power is prodigiously great; and the immense bodies of nearly stagnated water in the numerous canals that have been cut within the assigned period.

CHAPTER II.

On Evaporating Surface, Trees, Fences, &c.

I HAVE already mentioned, that the climate of England experienced an amelioration at the time agriculture began to be generally practised; it does not appear by the information we possess from the ancient writers before quoted, and other writers of early events in our Island, that the natives of Britain had made any considerable progress in the art of raising corn, when first visited by the Romans. We may therefore, on good authority, venture to date the general commencement of a system of tillage from about twenty centuries ago. The lands first appropriated to the culture of grain were probably surrounded by a fence, or foss, of some description, against depredations on their flocks and herds, or as lines of demarcation for ascertaining property; or rather as terminal marks of the different individual or collective proprietors or cultivators; for property being, at that period, chiefly *allodial*, they were generally the same.

For the early inhabitants, in the time of the Roman invasion, and long subsequent to that period, kept their flocks and herds from the arable lands by herdsmen, shepherds, and swineherds, who tended them by day, and folded them by night; at first probably for security and rest, and afterwards for improvement and profit; a remainder of which practice may still be witnessed on the extensive downs, denominated *Salisbury plain*, the *chalk hills* of Surry, and the range of hills called *Percelly*, in Pembroke. In the unsettled state of early society, the inclosures, if lands were inclosed at all, doubtless included considerable tracts, perhaps equal to one, two, or three of our modern parishes, the occupiers holding their lands in common, or what, in ancient law records, is called ***Redwal Tenure****. Thus a number of persons, having a joint interest, were better enabled to resist every kind of trespass, whether arising from the aggression of man, or the depredation of brutes. These original boundaries of then cultivated lands, in subsequent periods, especially during the existence of the Feudal system, probably marked the extent of the respective manours. A foss of this kind ran along the ridge of the Malvern Hills in Worcestershire, and is said to have been a manerial boundary, dividing the lands of Gilbert de Clarc, Earl of Gloucester, from the adjacent demesne, appropriated to the church of Hereford. The continuance of the Feudal system must have long raised insurmountable barriers to the extension of inclosures; for these would have been increasing impediments to the taste for sports of the field, of coursing, hunting, and falconry. This system of clearing and cultivating kept extending over the vale countries for several centuries, which, in the course of time, became tolerably thinned of their timber. The christian religion having been introduced, now occasioned frequent journies both of the clergy and laity to the seat of their spiritual head, the city of Rome. From this circumstance, our ancestors necessarily became acquainted with many of the arts and refinements of their more polished southern neighbours, both in France and Italy. Numerous exotic fruits were probably introduced by their itinerant devotees, or ecclesiastical politicians. Soon after this period, the spirit of travelling extended its views, and our ancestors visited the eastern countries of Europe in shoals, and even penetrated towards the seats of learning and arts, as far as the *land of Syria.* The holy war, as it was termed, or the crusades for the recovery of Jerusalem from the infidels, the then powerful empire of the Saracens, formed a peculiar epocha in English history. Out of the vast numbers that inlisted under the banner of the cross, we may suppose there were some whose minds were directed to other objects besides those excited by the religious frenzy, which animated the bosoms of the many; especially on their return home, when the enthusiasm of the mind was a little abated. To all desirous of benefiting their country, as vegetable nature here presented to their view various trees, shrubs, and fruits they were unacquainted with, now going to turn their attention to the arts of peace, the idea of benefiting their native country, by the introduction of new species of useful trees and plants, would naturally occur to their minds. It is probable many living specimens of exotic trees, both for ornament and use, were then introduced; the elm, walnut, chestnut, and Lombardy poplar, with a great variety of others, perhaps, made their appearance in England *then,* for the first time. The elm*,

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* See a very satisfactory account of this mode of usage and occupation, in the Reverend Mr. Evans's Tour through South Wales, 1803; and this custom evidently arose from that desideratum so strongly pursued in all, but more especially in the early states of society, *the security of property.*

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* Thomas Miller observes, that the first four varieties, including the English elm, are common in various parts of England. It is a fact that our nursery-men procure their seeds from abroad, as it is generally believed that they were

Ulmus campestris, of which there are nine varieties distinguished by Miller, are said, with the exception of one or two, not to perfect their seeds in this country. The common elm, called by way of distinction (though improperly) the *English elm,* will sometimes produce seeds in England. The wallnut, Juglans regia, the chestnut, Fagus castanea, and the horse chestnut, Æscalus hippocastanea, undoubtedly are exotics; but of the chestnut, Fagus castanea, there is perhaps room for doubt; for though Evelyn thinks it indigenous, it is generally found to thrive best in the *southern countries*; and Miller observes, that the best way to propagate it is by procuring the

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not originally natives of this country; yet notwithstanding what Aubury informed Ray, that there are none to the north of Stamford in Lincolnshire, and that Evelyn says they were originally brought from Lombardy, yet it is certain we possessed the elm as well as the oak in the Saxon times; and Hunter justly observes, there can be no stronger proof of the elm being a native of England than, that there are near forty places which take their *names* from it, and most of them mentioned in Doomsday-book.—"Evelyn's Sylva," by Dr. Hunter. The matter, however, still remains, "sub judice," and we are ever open to conviction.

It is, however, a strong fact in opposition to this reasoning, that the elm, the beech, the poplar, and box, are of *Roman name,* no such trees having any appropriate names in *the ancient British language*; and the existence or non-existence of names is a presumptive proof, supported by analogy, of the locality of things, in any particular country.

nuts from *Spain or Portugal.* Cæsar, we are informed, procured it from Thessaly, and from Italy through Gaul, it was derived to us: and an additional reason for their not propagating their seeds fit for fecundity, may be found in the luxuriance and size observable in trees of this genus in the south of Europe. The horse chestnut (Æscalus hippocastanea) was brought to us about the latter end of the sixteenth century, from Constantinople; for *Gerrard,* in his Herbal, speaks of it as a *foreign tree*; and Johnson, in his edition of 1633, says, "the horse-chestnut groweth in Italy and in sundry places of the east countries; it now groweth with Mr. Tradescant, South Lambeth." In the commencement of the last century, they do not appear to have been very generally planted or known. Houghton, in the year 1700, mentions this tree as rare, and that it would not stand our winters well; it is, however, so far inured to our climate now, as to defy the severest weather, growing to a large size, and producing annually a great quantity of fruit. From its patulous foliage and elegant flowers, it has been generally adopted for planting avenues, in which it certainly affords, during the heat of summer, a most luxurious and agreeable shade; but if the number of these trees be great, or too near our habitations, they increase the humidity, and consequent unhealthiness of the circumambient air, by the prodigious quantity of moisture they perspire from their leaves; so that they should be always planted at such distances as to admit a free circulation of air between them and the buildings, that the damp and contaminated air may have room to escape. The Lombardy poplar, Populus græca, was introduced from a province in Italy, as its name imports.

I have thus briefly noticed the principal exotic timber trees generally planted in hedge rows about the country; but to enumerate the endless variety, that modern luxury has introduced into the extensive and crowded plantations of the Nobility and Gentry, would require a volume; it is sufficient to say, that resort has been had to the four quarters of the globe for new species of trees and shrubs, to gratify this insatiable passion for vegetable variety. Our esculent fruits of the Icosandria class are almost all of them exotic. Of the genus which includes our cherry, plum, and other valuable fruits, out of thirty-three varieties enumerated by Miller, we claim but seven as indigenous, i. e. Pinus sylvestris, P. padus, P. avium, P. cerasus, P. domestica, P. insititia, and P. spinosa. We are told, however, by a modern physiologist of distinguished merit, Mr. Knight, *that the cultivated apple is not a native of any soil or climate, but pro-*

duced by cultivation from the crab, Malus sylvestris, which is an indigenous tree in all the temperate European climates. The learned and observant author of the treatise on the *apple and the pear,* from the silence of our early Botanists on the subject, asserts, that the apple is not the indigenous tree of any country in Europe, but owes its existence to the art and industry of man, differing from the crab, which is common to every part of England, only by the changes which have been produced on it by cultivation. The first varieties were doubtless produced by grafts or plants from the Continent, but at what time is not known. Previous to the time of Henry VIII. in the time of Parkinson, were enumerated fifty-seven varieties, and Ray, in his catalogue, has seventy-eight sorts; but (without quoting his authority) he says " the cyder apple trees were originally brought from Normandy." *Withering's Bot. Vol. II.*

Having particularised the principal exotic forest and fruit trees, which are generally cultivated in England, I shall proceed to show, that the evaporating surface of this kingdom, exposed to the influence of the sun and air, is much greater at the *present time than it was some centuries past.* Several interesting experiments were made on the evaporating power of vegetables by Dr. Hales, and published in the Philosophical Transactions near a century ago;

and in his Vegetable Statics, vol. i. he found, by exposing a sun-flower plant, Helianthus annuus, to the influence of the sun and air in a garden pot, carefully guarding against any evaporation, except what arose from the process of vegetation, that a plant, weighing three pounds, perspired about thirty ounces in twelve hours during a day in the month of July, but in a warm night perspired only three ounces, and lost nothing in a cold night—on the contrary it gained weight by imbibing dew. He found, that when the perspiring surface was diminished by removing the leaves, the power of exhaling moisture nearly ceased; a plant so circumstanced, which before evaporated thirty ounces in twelve hours, now only exhaled one ounce. A variety more of such ingenious experiments may be found made by *Hales*, the most indefatigable investigator of vegetable physiology, all tending to demonstrate *the evaporating power of plants*; more especially of foreign derivation. Wishing to institute a fair comparison between this power as it exists in heat or cold, dryness or moisture, night or day; and finding, from my own observations, and the experiments of others, that the aqueous moisture exhaled from vegetables, proceeded principally from *the leaf**; and as it would require great length of time to get forest trees to grow in pots for the performance of experiments on their evaporation, I was obliged to have recourse to another method: I separated various leaves from the trees on which they grew, with their footstalks entire; these were weighed in the morning as soon as the dew was gone off, the footstalks being touched with an unctuous substance to prevent any loss from the incision; these were then placed in the open air in a situation similar to that in which they grew, and with their upper surfaces exposed to the sun. I am well aware of an objection, that the loss from

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* Mr. Knight, in a paper of his published in the Transactions of the Royal Society observes "that the *leaf* is the

chief laboratory on whch nature prepares the juices of plants, and fits those of the same stock to nourish fruits of different forms, flavour, and colour, the width and thickness of the *leaf indicating the size of the future apple.*" This remark seems, though new, to be confirmed by observation, the Pyrus sylvatica and the P. malus having much smaller and thinner leaves than the cultivated varieties. The same ingenious and patriotic author has proved by his experiments on the exhaling power of vegetables, that the moisture proceeds from the *under*, and not the *upper* sides of the leaves. He found by carefully fastening dry plates of glass to the upper and under sides of some vine leaves, that the *under* only exhaled moisture. Vid. Knight on fruit trees.—I have tried many experiments which confirm this. I have frequently covered both surfaces of leaves with oil, and after carefully weighing them before and after their exposure to the sun and air, discovered that evaporation was prevented *only, when the under surface of the leaf was so covered.*

evaporation is much less, as the supply of vernal sap is cut off from the parent tree, when a leaf is so separated; but still some comparison may be made so as to ascertain whether or not *exotic trees*, the natives of warmer climes, exhale *more than indigenous ones peculiar to our own.* It will be proper here to mention also a necessary caution in conducting experiments according to this method. The leaves of trees intended to be subjected to experiment, in order to form a just comparison with others, must be separated from trees as nearly as possible in the *same state of growth*; as the active power of newly-expanded leaves is greater than those of maturer age: and, without this precaution, considerable errors may attend the results. Further I found, when the air is very dry, and attended with wind, leaves will not bear to be sufficiently exposed for the purpose of experiments for the space of twelve hours, as both will often lose the perspirable matter; so that when weighed at night, the quantity exhaled would appear the same. For instance, suppose an oak leaf at eight A. M. to weigh eight grains, and one of elm to weigh the same, by two P. M. the leaf, which parts with its moisture most easily, *the elm*, may be quite dry, and at eight, P. M. the oak may be equally dry; a less time, in such cases, must be adopted for trial. Having ascertained these necessary points, I proceeded to make numerous experiments, all affording similar results; some of which I shall here, for the reader's satisfaction, detail:—

Experiment 1.—A leaf of the common English oak, Quercus robur, was separated from the tree, and weighed, at nine, A. M. fourteen grains; it was then exposed to the open air, in a situation similar to that in which it grew, and again weighed, at nine P. M. ten grains.

Experiment 2.—On the same day, a leaf of the common elm, Ulmus campestris, weighed, at nine, A. M. five grains; at nine P. M. two grains and a half.

Experiment 3.—A sprig of common hawthorn, Cratægus oxyacantha, consisting of eight leaves, weighed, at eight A. M. sixteen grains; at eight P. M. nine grains.

Experiment 4.—A similar sprig of evergreen thorn, Mespylus pyracantha, weighed, at eight A. M. sixteen grains; at eight P. M. weighed thirteen grains.

Experiment 5.—A small sprig of hawthorn weighed at nine A. M. forty-eight grains, at nine P. M. weighed twenty-nine grains.

Experiment 6.—A similar sprig of common holly, Ilex Aquifolium, at nine, A. M. weighed forty-eight grains; at nine P. M. weighed forty-six grains.

Experiment 7.—A small sprig of common furze, Ulex europæus, at eight A. M. weighed seventeen grains; at seven P. M. weighed sixteen grains and a half.

Experiment 8.—A sprig of Scotch fir, Pinus sylvestris, at seven A. M. weighed seventy-four grains; at seven P. M. weighed seventy-two grains and a half.

A great number of other experiments were tried early in the summer on different trees, but the weather was so wet that the results could not be depended upon; for had I covered the leaves with glasses to secure them from the rain, I was apprehensive that false deductions might have been made.

By comparing the results of the foregoing experiments, we find that the oak leaf lost less than a *third* of its weight, while that of the elm lost *one-half*. The elm, therefore, gave out moisture to the air almost at a double rate. The next experiment was made to endeavour to ascertain whether or not the exhalation from the fences, which intersect our fields, might not be lessened by substituting other shrubs or plants for those now generally used; and we find that a sprig of common *hawthorn*, consisting of eight leaves, exhaled seven grains out of sixteen, and a similar sprig of the *evergreen thorn* only lost *three grains out of sixteen*. The next comparison was the hawthorn with the holly: each weighed, previous to the experiment, forty-eight grains; the hawthorn exhaled nineteen grains, and the holly only two grains. The loss of the furze was *only half a grain in seventeen grains;* and the *Scotch fir a grain and a half in seventy-four grains.*

On comparing the results of other experiments on the native and exotic fruit trees, I found the exhalation always least from the indigenous trees; the native crab and pear being less than the cultivated varieties, and that of the sloe and bullace still less, compared with the orlean and green-gage plum. The conclusions evidently resulting from these experiments are, that the exotic vegetables cultivated in this climate still retain their original capacities, which were given to them by the beneficent Creator, who doubtless formed trees and herbs of various qualities, best suited to the peculiar climate in which it has pleased him naturally to appoint them habitations: and that men have incautiously removed such vegetable productions, still retentive of their habits, into situations where the sun's influence is insufficient to dispel the vapourous atmosphere they continually generate.

I flatter myself I shall be able to make this remark still more evident, when I come to treat of *Electricity in the process of evaporation.* Having noticed the arboreous vegetables planted about our mansions for use and ornament, and those usually found in hedge-rows, for supplying the country with timber, fuel, and other purposes, We come next to consider the general surface of the ground. The increasing population for some centuries past requiring a greater supply of food for the increasing demand, has occasioned large tracts of waste lands to be brought into cultivation. The use made of these lands, before they were subjected to the operations of the plough, was principally to afford pasturage for sheep and cattle, and consisted of the natural grasses mixed with moss, gorse, fern, foxglove, &c. &c.; and in some situations were seen the various tribes of heath, broom, and other mountainous and bog plants. Most of these native productions, I find from experiment, exhale but a small proportion of moisture. They likewise possess another quality, that of *protruding their vernal leaves late in the spring*, which I shall prove to be of vast importance, when I come to consider the different effects of a moist or a dry atmosphere, during the bloom of our dessert and cyder fruit trees. The natural soil of these extensive tracts of land, being improved by the advances made in agriculture, and intersected at the distances of eight or ten, to fifteen or twenty acres, by hawthorn fences, and their attendant appendages of weeds, which usually adorn the banks; with the luxuriant crops of gramineous and leguminous plants, raised within these small inclosures, exhale moisture in spring, but in summer a prodigious quantity, from this increased vegetable surface, beyond all proportion greater than when in a state of *waste*.

The following table contains the number of acts of parliament, which have been obtained for the purpose of inclosing waste lands, or altering or enlarging the powers granted in such acts, since the accession of George the First.

George I.

1,	1714,	—
2,	1715,	—
3,	1716,	—
4,	1717,	—
5,	1718,	—
6,	1719,	2
7,	1720,	1
8,	1721,	1
9,	1722,	—
10,	1723,	—
11,	1724,	1
12,	1725,	3
13,	1726,	1

George II.

1,	1727,	1
2,	1728,	4
3,	1729,	6
4,	1730,	5
5,	1731,	3
6,	1732,	3
7,	1733,	1
8,	1734,	2
9,	1735,	4
10,	1736,	2
11,	1737,	4
12,	1738,	3
13,	1739,	5
14,	1740,	4
15,	1741,	3
16,	1742,	5
17,	1743,	8
18,	1744,	1
19,	1745,	2
20,	1746,	1
21,	1747,	3
22,	1748,	5
23,	1749,	2
24,	1750,	5
25,	1751,	5
26,	1752,	8
27,	1753,	4
28,	1754,	14
29,	1755,	10
30,	1756,	21
31,	1757,	17
32,	1758,	26
33,	1759,	34

George III.

1,	1760,	21
2,	1761,	38
3,	1762,	19
4,	1763,	38
5,	1764,	65
6,	1765,	58
7,	1766,	53
8,	1767,	34
9,	1768,	64
10,	1769,	54
11,	1770,	63
12,	1771,	74
13,	1772,	65
14,	1773,	62
15,	1774,	40
16,	1775,	55
17,	1776,	91
18,	1777,	63
19,	1778,	67
20,	1779,	37
21,	1780,	21
22,	1781,	17
23,	1782,	16
24,	1783,	15
25,	1784,	21
26,	1785,	24
27,	1786,	20
28,	1787,	34
29,	1788,	32
30,	1789,	24
31,	1790,	40
32,	1791,	41
33,	1792,	60
34,	1793,	73
35,	1794,	76
36,	1795,	67
37,	1796,	87
38,	1797,	51
39,	1798,	68
40,	1799,	87
41,	1800,	126
42,	1801,	107
43,	1802,	65
44,	1803,	49

Thus we see that during the two preceding reigns of George I. and II. the number of inclosing acts for the space of forty-five years was two hundred and sixteen; and during the same space, in the reign of his present majesty, the number amounts to the enormous sum of two thousand two hundred and eighty-two. And though a few of these have included powers for draining fens and marshy grounds, yet the drains are principally *Reins*, containing stagnant, or slow-moving water; so that though the lands may be more healthy, the evaporating surface is but in a small degree diminished. Mr. Fulton asserts that the number of acres inclosed the last fifty years only, amount to two millions eight hundred thousand.—*Vid. Monthly Mag. No.* 133.

The number of these inclosures, which have taken place within the last thirty years, may by itself satisfactorily account for the increased coldness and humidity of our summers, since the year 1770 and 1773. Agreeably to a late publication, (Middleton's View of the Agriculture of the County of Middlesex) the cultivated land in England amounts to thirty-nine million twenty-seven thousand acres, and the commons and wastes to seven millions eight hundred and eighty-nine thousand; therefore the total of England and Wales amounts to forty-six millions nine hundred and sixteen thousand acres.

The cultivated lands in Scotland are upward of twelve millions of acres, and the uncultivated fourteen millions of acres; so that on comparing the proportion of wastes in the two countries, we find about a fifth part uncultivated in England, and more than *one-half* in the same state in Scotland. Timber and hedgerows too are much more numerous in England than in Scotland. The principal part of the timber in Scotland, let it be recollected, consists of the *Pinus sylvestris,* a tree that exhales but little moisture; for by experiments in a sunny day, attended with wind, the end of a small shoot, with its leaves, was exposed in the open air during eleven hours, *and only lost a grain and a half out of seventy-four grains.* Much less cloudy skies and wet weather might, from this circumstance, be expected in summer in the latter, than the former country; accordingly writers inform us, that the climate on the *north-east coast* of Scotland is more fair and dry than England or Ireland. The warm humid south-west and westerly winds brought in from the Atlantic Ocean, passing over this dry country, is not so disposed to form clouds, and consequently rain, owing to the more complete insulation of the vapour, and the diminished quantity of evaporating substance on the surface.

CHAPTER III.

On the Disposal of Vapour arising from Vegetable Surface.

I SHALL now endeavour to shew what becomes of this aqueous vapour, exhaled from vegetables, and from the moist surface of the Earth and Sea. I confess the subject to be extremely difficult; I feel the weight as well as the importance of it.

The process of nature, by which rain or fair weather is produced, has hitherto much perplexed the ablest philosophers from Aristotle, who attributed the formation of vapours to the action of fire, till Le Roy, who resolved every meteorological problem by means of chemical dissolution; so that our meteorological discoveries have proceeded very slowly towards certainty. However, the researches into this department of science have not been altogether fruitless; for within a few years past several invaluable discoveries have been made; the identity of lightning and the electricity excited by art, was discovered by the French philosophers, and exemplified by Dr. Franklin in 1752; but the only great practical use made of this discovery at the time, was, the application of *conducting rods*, which were attached to buildings, and the masts of ships, to protect them from the dreadful effects produced by sudden lightening. However, one very important point was gained towards forming a theory for elucidating the process of nature, in the phenomena of the weather.* The conclusions drawn from this discovery gave rise to numerous and varied theories, intended to explain how the clouds became thus electrified; and how they were disposed to part with their electricity. Some supposed the electric matter emanated directly from the Sun in rays, which were prevented from falling on the Earth's surface by the opacity of the clouds, till they became, by accumulation surcharged, when they burst forth in those terrible explosions, commonly denominated thunder and lightening. But no experiments hitherto made have at all satisfactorily supported this conjecture. Philosophers are agreed, that most bodies are surrounded with a peculiar fluid, more rarified than common air, which forms around them a kind of atmosphere to a given extent; various optical and electrical experiments confirm this opinion. The vapourous vesicles themselves demonstrate the existence of a similar atmosphere surrounding them by the facility with which they move on the surface of water; a medium supposed congenerous with them, without uniting with it; for if they were in immediate contact, they would, by the force of attraction, immediately unite with the medium on which they float: the same may be observed of dust blown over the surface of any liquor. What, then, is the nature of this atmosphere? Is it fire? so far, then, it would not be observable, as it is, in clouds, which are nothing but an accumulation of such vesicles apparent in the most rigorous winters, The diminution of cold during winter, which accompanies rain, indicates that these vesicles have, in forming water, relinquished a portion of fire in a certain state, employed in their suspension. Is this the electric fluid? Yes. The interior of these vesicles are *hollow spherules,* for they appear larger when they are heated: they must therefore contain a fluid expansible by heat, and their lightness excludes the idea that it is *dense* air. This fluid is doubtless the *same as their atmosphere*; and if the outward envelope, or atmosphere, be removed by any conductor, the internal air tries to escape, which produces the attraction of each other to form larger drops. When these vapours are condensed by extreme cold, the water which forms their envelope crystallizes sometimes into snow or hail, or, when it attaches itself to solid bodies, into ice; in this state it is *concrete vapour*.

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* Might not lofty trees, such as Lombardy poplars, be substituted near houses, instead of metallic rods?

We here find a reason for those reverses which so often follow the electric explosion of clouds. The electric fluid, every time it abandons a cloud, allows the vesicles to condense which it held dilated, and round which it formed an atmospheric envelope. These vesicles being suddenly, by one of these explosions, deprived of the power which sustained them, become massy drops, and tend to form those tremendous rains which the common people attribute to *Tonneres tombés en eau.—Vid. de Saussure.*

It has long been observed as a wonderful phenomenon, hitherto unaccounted for, that heat applied to water, at the temperature of 32°, causes a diminution in the bulk of the fluids. What is the cause of this contraction? The water contracts, and continues to contract with the increase of temperature, till it reach the 40th or 41st degree; between these points and the 42d or 43d, it suffers scarcely any susceptible change; but when heated beyond this, it expands in proportion to the communicated heat. To ascertain this well-known fact, Dr.

Hope, of Edinburgh (*vid. Philosophical Trans. Edinb.*) instituted a set of new experiments, the best and most decisive of which are as follows: *Experiment* 6. "I filled the jar with water of the temperature 39½°, the air and support being 39°. Thermometers were suspended near the bottom, and just below the surface of the fluid in the jar; a mixture of snow and salt was introduced into the basin about the middle part,

	Bottom.	Top.	Air.
At commencement	39 — 5	39.5 —	39′0
In ten minutes	39 +	38 +	
In twenty-five ditto	39	36.5	
In thirty-five ditto	39	36 —	
In fifty-five ditto	39 —	35	
An hour and ten ditto ..	39 —	34 +	
An hour and thirty-five do.	39 —	34 —	
Two hours	39 —	33 +	

"This experiment," Dr. H. observes, "shews, that when a position in the middle of a column of water, at temperature 39° 5″, the cooler fluid rises, and does not descend through the warmer mass; and presents the unequivocal demonstration, that water, at the temperature 39½°, is *actually expanded by losing heat.*"

The author concludes, that the general purport of his experiments is, that water, ice, or any other substance a few degrees warmer, when heated becomes *specifically lighter*; that water, above 40°, by the loss of heat or by cold, is rendered *specifically heavier*; and that water below 40° is rendered specifically lighter. Hence heat in low temperatures causes water to contract, and at superior temperatures to expand; and that this point, in which the change of temperature takes place, lies between 39½ and 40°."

This appears a strong corroborating evidence in proof of the vesicular theory, since it cannot arise from the change in the atmosphere, the temperature during the experiment remaining the same; may it not, therefore, be satisfactorily accounted for thus.—When the heat was applied to water in the lower temperature, the air contained in these vesicles was expanded, the vesicles burst, and the attractive force of the surrounding particles operated; so that larger ones were formed, occupying a less space, till no farther room admitted condensation; when a contrary effect was produced by a separation into similar vesicles by the same means. And may not the phenomenon of masses of solid ice floating in water be attributed to the same cause?

The discoveries made about twenty years since by Messrs. Volta, Lavoisier, de la Place, de Saussure, and others, have proved, beyond all doubt, that the electricity of the clouds arises from the evaporation of water by the heat of the Sun. The air of our atmosphere is capable of dissolving a portion of water, and suspending it in a state of vapour. This union and suspension is effected by the combined powers of heat and electricity. Water, when in a state of complete *solution*, that is, when its particles are very minutely divided, does not destroy the transparency of the air; clouds appear only when the vapour is floating in a state of *mixture*. The increased capacity of water for electric matter, when in a state of vapour, is clearly shewn by the following experiment:

Insulate a funnel so as to prevent its receiving, or giving electricity to the surrounding bodies; then place in it some red hot coals, or pieces of heated brick; upon these pour water, which immediately combines with the heat, and assumes the state of vesicular vapour, or cloud, carrying off the natural electricity of the vessel and its contents; the ascending steam is electrified positively, and the descending water, which was not volatized, passes through the vapour, and is electrified negatively.

To those of my readers, who may be unacquainted with the common principles of electricity, it may be necessary to explain the meaning of the terms *positive* and *negative*. Before the science of electricity was much advanced, philosophers differed in the terms made use of to describe the *two states*; and as they used globes composed of different materials, as resin or glass, when the excited fluid assumed a contrary state, they called it *vitreous* and *resinous* electricity. But more recent experiments have proved it to be one and the same fluid, only existing in *different states.* Thus when a body is changed with a greater proportion than ordinary of this singular species of matter, it is said to be electrified *positively*; but when this quantity is diminished, we say it is electrified *negatively*. It is true, some of the phenomena attending electrical experiments seem not satisfactorily explained, but on a thorough acquaintance with the subject, the apparent contradiction of theory entirely vanishes; and when we come to consider the different states of the atmosphere with respect to electrization, we shall see the necessity of bodies mutually repelling each other, when they are, electrified *plus* or *minus.* Numerous experiments of the late Mr. Bennet, and other celebrated Electricians, all tend to confirm the fact, that when water is combined with heat in a state of vapour, it assumes an electric appearance.

Further experiments on the same subject seem to shew that the electric fluid is capable of pervading and forming part of solid bodies; and when a new combination, the consequence of previous decomposition is formed, the electrical results of evaporation have been different. Thus Mr. Bennet found, on heating an iron chissel, and dropping it into a vessel of water placed on the cap of his gold leaf electroscope, that the gold leaf opened *slowly* negatively, then closed, and opened positively, and thus remained to the end of the experiment. The chissel was again heated to a greater degree, and the gold leaf struck the sides of the instrument several times negatively; it then changed, and stood at half an inch positively to the end of the experiment. It was now repeated with the chissel heated more intensely than before; it struck the sides often negatively; after which it closed, but never opened positively. Upon observing the chissel, its surface appeared much *oxydated*; the oxyd was removed, and the experiment repeated, which afforded the same results as at first. The deductions to be made from these experiments are, that at the instant the chissel was immersed, the water was simply evaporated; the vapour therefore carried off the natural electricity, and the cap of the electroscope, with the vessel containing the water, was electrified minus; the gold leaf therefore opened negatively; but on the chissel's remaining in the water, a partial decomposition took place; one of the elementary substances of the water, the *oxygen*, united with the iron, and oxydated its surface. Latent or combined electric matter was therefore set at liberty, either from the water or from the iron *, which was sufficient to supply electricity to the ascending vapour, and to exhibit a redundancy, as the gold leaf opened positively.

This I think is demonstrative evidence, that the opinion before advanced, respecting the cause of atmospherical electricity, is true. Atmospheric air, therefore, is capable of dissolving water, and holding it in a state of suspended vapour by means of heat, and the electric fluid; and, on contemplating this process, we are compelled to admire both the wisdom and the goodness of God †, in this admirable contrivance.

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* The newly-discovered species of electricity called *Galvanism,* usually made apparent to the senses by the application of copper and zinc to water, by means of what are called Volta's plates, or Pile, appears, from late experiments, to be only a *modification of the same substance.*

† Not only in this, but in every part of creation, these attributes are strikingly visible; for the more we investigate nature, the more we are astonished at the wonderful art and contrivance displayed by the Creator in the formation of the universe; every thing we see being so admirably adapted to produce the intended effect: and the farther we push our inquiries, the more we discover that the clue leads on to infinite perfection. The late learned and amiable Archdeacon Paley, in his able and masterly defence of revelation, certainly attacked Atheism in its most vulnerable point, by selecting the curious mechanism of organized bodies; from the exquisite contrivance of which he asks the obvious question—" Could this come by chance? the random coincidence of fortuitous atoms?"

For if the union of air and water had been effected by *heat only*, we must have had perpetual diurnal showers; and in the night all the water raised by the solar heat from the seas, lakes, ponds, rivers, brooks, the surface of the Earth, dew, and vegetable foliage, would, when such heat was withdrawn, have been precipitated in one immense torrent, inundating the country, and destroying its inhabitants. As soon as the vapour became condensed, the particles of water, containing nothing to keep them asunder, would have obeyed the law of cohesive attraction; to which would have succeeded the attraction of gravitation, and all the water, not chemically combined with the atmosphere, must have been suddenly precipitated to the earth: the effect would have been the same as that which takes place when steam is condensed in close vessels during the progress of distillation. The instant that a particle of water is evaporated by heat, and escapes from the surface of the sea, earth, or leaves of vegetables, it assumes an electric state, owing to its acquired increase of surface exposed to air*. These particles of water, when first detached from the surface of the earth, are supposed to assume the form of *vesicular spherules*. To those who have paid but little attention to electric phenomena, this subject may require illustration. Suppose, then, for instance, fifty very minute particles of vapour to exhale from the surface of the earth, each conveying with it a small proportion of electric matter, these fifty integral, though minute spherules, when condensed, will be formed into an *aggregate globule*, whose bulk is increased in a higher ratio than its surface: the intensity of its electricity consequently will be greater, which is rendered familiar to the sight by the above experiment.—*Vid. Franklin's Philosoph. Works.*

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* Perhaps this process was permitted to take place generally at the deluge; the electric fluid being withdrawn for a given time, the rain would continue during the same, according to the account given in Gen. vii. 12: that space was forty days and forty nights. The electric fluid being again

The singular property of bodies assuming an elective state, when their surfaces are increased and suspended in a non-conducting medium, is not peculiar to aqueous vapour only; for if you put powdered chalk into the pipe of a bellows, and blow it upon the cap of the electroscope, placed at the distance of six inches, the cap becomes electrified positively. If water is divided by passing it through small holes, as in a syringe, the particles of water, if collected on the cap of the electroscope, will be found positively

permitted to act, evaporation again commenced, (Gen. viii. 1.) which, in the course of a few months, restored the earth to its former dry and habitable state, Gen. viii. 13.

electrified. Numerous experiments, in confirmation of this, were made by Mr. Bennet, and are recorded in the papers of the Royal Society of 1787.

Notwithstanding the abstract reasonings of Desagulieres, and others, against the globular shape of vapourous particles, observation demonstrates this to be the form they invariably assume. They may even be seen, in some cases, by the naked eye. Thus exposed to the rays of the sun, and in a place where the air may not agitate, a cup filled with some hot aqueous fluid, of a black or dark colour, as coffee for instance, there will proceed from this liquor a vapour more or less dense, which will ascend to a certain height, and then disappear. The eye of an attentive observer will easily discover that this vapour is composed of numerous *rounded whitish grains* detached from each other. Would we wish for more light on the subject, we must view them with a double convex lens, of about one inch, or an inch and a half focus; if we observe attentively with this lens what passes upon the surface of the liquor in the above-mentioned state, we shall perceive *spherical bubbles* of different magnitudes to arise from the surface, by a different celerity of motion; the smallest, or fine, will rise with rapidity and become invisible, while the larger, or more gross, will fall back into the cup, without mixing with the liquid, rolling on the surface like light dust, subject to the impulse of air; for on breathing we may drive them from side to side of the vessel; nay, when there is no perceptible agitation in the air, we may see those globules suddenly in motion, the smaller coalescing with the larger, which still preserve their station on the surface: others, which were elevated in air, are seen descending and coalescing as the former, or sometimes again reuniting with the liquor which first gave them birth. The lightness of these spherules, their whiteness, and different appearance from *solid globules*, leaves no doubt as to their nature. It is sufficient to see them to obtain conviction that they are *hollow spheres*, similar to the bubbles apparent on agitated saponaceous suds. These being specifically lighter than the surrounding medium, consequently ascend till they attain the higher regions; in this state they do not destroy the diaphanous state of the atmosphere; for they do not change the apparent form of the planets. And this arises from the fact, that rays of light passing through extremely minute meniscous transparent bodies, suffer no sensible deviation or aberration; their electricity is, in this stage, in the weakest state in these colder regions. And the rapidity with which this solution of vapour is effected, forms a probable criterion to judge whether the day will be fair or showery; and the quickness or slowness with which the solution takes place, appears to depend on the greater or less proportion of electric matter present. They are now condensed, a number of their minute particles unite by the law of cohesive attraction, and form a globule of greater bulk, but whose surface is not increased in the same ratio; consequently the intensity of the electricity becomes greater, as shewn by the Franklinean experiment of the *can and chain.* These enlarged particles do not permit all the rays of light to pass, like the smaller ones; the transparency of the sky is therefore destroyed, and the combined arrangement of a series of these larger particles forms a cloud or fog. These enlarged particles are kept asunder by the repulsive power of electricity, in the same way that two pith balls are when electrified by art; otherwise they would unite from the attraction of cohesion, and immediately form drops of rain. Clouds are sometimes found negatively electrified, owing to the influence of an atmosphere strongly electrified positively; as is explained by the phenomena of the Leyden phial. The particles of vapour, forming such a cloud, are likewise kept from coming into contact by negative repulsion.

I shall now proceed to describe the process by which rain or fair weather is produced; beginning with the atmosphere in that state which usually in England succeeds a maritime storm of rain from the S. W. in the summer months. The wind generally changes in the afternoon to the N. W., or W. N. W.; a bright star-light night succeeds, with a rising barometer. The sun next morning commonly rises bright, and not an obscure spot appears on the horizon; about seven, eight, or nine o'clock, according to the sun's elevation, which depends on his declination at the season of the year the observation may be made; light fleecy clouds arise, and pass over from the north-west*: by looking with an attentive eye on the edges of these clouds, and observing the smaller detached portions of vapour, we perceive them to melt into clear transparent air by the action of the solar rays. As the day advances, the solar rays, falling more perpendicular, increase the evaporation from the surface of the ground; the index of the hygrometer shews this atmosphere to be drier from the vapour having been exhaled. The clouds now increase rapidly in number and size, and their lower surfaces, which are in shade, become visibly darker; still the edges and detached parts, on which the sun shines, continue to dissolve into transparent air. If the rising particles of vapour, now arriving in the cold region, come up in quantities greater than the heat of the sun can dissipate; then the sky becomes uniformly obscured, or the vapour unites into large dark masses, some of which, outsailing others, are thus overtaken, and the principal cloud rapidly accumulates; the under surface appearing very dark: as the cloud approaches the observer a sudden squall of wind arises. The electroscope being now elevated with its lamp, the atmosphere, which before scarcely showed a sign of electricity, is now found to be strongly electrified. The cloud becomes more dense in consequence of the large particles, whose electricity is strongest, attracting those whose intensity is least; these united particles becoming too heavy for longer suspension in the form of vapour, fall to the earth by their own gravity; and, uniting with any smaller particles they may meet with in their descent, arrive at the earth in the form of hail-stones, or drops of rain. That the drops of rain increase in size* during their descent from the cloud, may be proved by ascending a high mountain in a rainy day, as they are *here* found much smaller than in the vale below; and rain gauges are found to collect less water on lofty steeples† than when placed on the ground. This appears from the observations of travellers, who have traversed very mountainous countries; by whom we are informed that, during heavy rains in the vallies, they have experienced but very slight showers on the summits of the mountains. The Reverend Mr. Evans remarks, that when on the top of Plinlimmon, in August 1805, he observed the wind to shift suddenly from the north to the

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* Cloud in spring, summer, or autumn, must always be expected more or less to arise in the course of the day, whenever the surface of the soil is moist, especially if attended with wind; as in this last case the evaporation of such moisture is hastened, and therefore more cloud is formed in a windy day than a calm one, whenever the earth is in a moist state. In addition to that which at these times arises from vegetables, the whole island may then be considered as consisting of aqueous surface.

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* The great Dr. Franklin, whose comprehensive mind led him to embrace a most expansive field of science, and whose discoveries in this have rendered him deservedly celebrated, thought, in his time, that experiments had not been sufficiently general and circumstantial to found an hypothesis; but observes, that the particles of water must accumulate in size and density, from some cause in falling from the cloud to the earth, which, he observes, may be effected two ways, either by the attractive power of aqueous particles in contact, or those more distant, by their different state with regard either to common or electric fire, or by these causes united. The first case he supposes *impossible;* the second he illustrates by two experiments:—

First, a dry glass bottle, filled with cold water, will presently collect, from the surrounding air, a quantity of water, which will be seen trickling down its sides, the cold water attracting the fire which had previously held the atmospheric water in solution.

Second, an electrified body left in a room, will be much more covered with dust than other bodies not electrified, which seems attracted from the circumambient air.—*Vid. letter from B. Franklyn, LL. D. to Dr. Percival.*

† A comparison having been made between the rain which fell in two places not a mile distant, led to the important discovery that, by placing the rain guage at different heights, the results will be different, and the quantity in an inverse ratio to the altitude; the fact has been ascertained by experiments made in various places. It is the business

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of philosophy to give a rational solution to the question—What is the cause of this inequality? Dr. Heberden conjectured it depended upon some *latent power of electricity.* This conjecture was well founded, and recent discoveries have developed this property. It has been ascertained, that the electric fluid is strongly attracted by water, and by destroying the cohesion between its particles, and repelling them from each other, it becomes a powerful agent both in evaporation, and in the formation of clouds. Thus when two clouds, which contain different portions of electric fire, come within the sphere of mutual attraction, they will rush together, and the electric fluid being diffused, the particles of water will unite, and, forming themselves into drops, a shower will be produced: and as the rain descends through an atmosphere but weakly charged, it will be continually communicating it to the drops, which will increasingly coalesce, and consequently a much larger quantity of rain will fall in a given space than at a distance from the surface of the earth. To this will contribute also the precipitation of vapours in a state of solution in the lower region of the atmosphere. It has been observed to be fair at the top of York Minster at the time there were drizzling rains, with thick mists, in the streets below.—*Vid. Hunter's Georg. Ess.*

west and south-west, when the air, that had been previously tolerably serene, became dark; large clouds appeared suddenly to accumulate, and rolling beneath the summit, descended lower and lower, and, in their descent, appeared darker and darker still: after two hours, the air became again transparent, the sun appeared, and after experiencing only a kind of mist on the mountain, he descended, accompanied by dry weather, to Brynlimmon, situate at its foot. "Often," he says, "when overtaken upon other and more lofty mountains by storms, I have sat down to view the formation of clouds, which I have seen arise over forests beneath me. No fog has been seen on their surface. The surrounding air has appeared transparent, and in an instant I have perceived a large dark cloud, where the eye was, a few seconds before, delighted with a clear sky." It is natural to suppose that this air was saturated with elastic vapours, dissolved in it by the electric fluid, and that it only wanted to be placed in a condition to change its elastic into a vesicular form, by a deprivation of its electricity, and, by a farther deprivation, to form clouds, and descend in rain. During the passage of a heavy cloud, the electricity is found to change, when the rain begins to fall plentifully. *(Bennet on Artificial Electricity.)*—The atmosphere being in the state I am now describing, we generally find, when the cloud first passes over the place of observation, that the electroscope opens negatively; but when the rain begins to fall it closes, and immediately opens positively: and again, when the storm is nearly blown over, the negative electricity again prevails as at first*. The wind now becomes more calm, the sun breaks out, and continues bright till the next storm passes over, when similar phenomena are again visible. In three or four hours after the sun has passed the meridian, his rays, falling on the earth with greater obliquity, occasions less evaporation; consequently, as less vapour is raised, the storms are not so frequent,

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* This extraordinary change of the electrical state of the atmosphere, which happens during the time a highly-charged cloud passes over the observer's head, may perhaps require some explanation. Some suppose it is owing to the influence of a strong electrical portion of atmosphere, always accompanying a highly-charged cloud; which opinion the observations I have made from experiments tend to confirm. The mass of floating vapour being charged positively in the method already described, occasions a stratum of air, negatively electrified, to move in a direction parallel to it, over the surface of the earth; this plate of air interposed, completely insulates the cloud, which now is in a similar situation to a charged Leyden Jar. While the cloud is positively electrified, the influencing state of electricity in the substratum of air on the earth's surface, becomes negative, and remains so till the rain falls, when it becomes like the cloud itself, and forms with it a connecting and conducting chain; but when the heaviest part of the cloud has passed over, the rain ceases to fall, and the influential state of electricity again prevails, till the cloud is completely past. Water is well known, whether in an aerial, fluid, or vapourous state, to be a conductor of electricity; that the air, in proportion as it becomes charged, is less coercive and less able to resist the diffusion and motion of the electric fluid; consequently they may form, to a great height, a communication between the immense reservoirs of electricity (this

ocean of electric fluid) and the mass of our globe, when the state is unequal between them, or there exists a disproportion between the quantity on or near the surface of the earth and the higher regions of space; the vapour will then become the traversing medium by which the equilibrium will be restored. However, from various causes this equilibrium is but of short duration; and while the vapours in ascending to the air, or descending to the earth, are constantly at work for the producing this equilibrium, it is as constantly being destroyed by agents which effect rarefaction or condensation; vapours never ascend a great height without producing various meteors. The eruptions of volcanoes are preceded or accompanied by thunder, &c.; hail, which supposes a considerable elevation of vapours, is invariably accompanied by electricity. De Saussure has remarked, that he never observed either hail or sleet where his electroscope did not give strong indications of aerial electricity, either positive or negative. The Aurora Borealis, it has been observed, is always accompanied by electricity. These no longer extraordinary lights are produced by the electric fluid in the moment when it is condensed, passing into columns of very elevated vapours. Storms, whirlwinds, waterspouts, and many earthquakes, owe their effects to torrents of electric matter, detached from immense vapours in the high regions of our atmosphere.—*Vid. de Saussure, Sur des Orages.*

the sky is clearer, and frequently at sun-set the atmosphere is quite transparent, and continues clear till next morning, when the same process recommences, We frequently find the air in this state for seven or eight days together after storms from the south-west. The peculiar appearance which the clouds assume at different times, seem to depend on the quantity of electric matter present, and upon the influence of adjacent aerial strata approximating to an agitated or quiescent state. The meeting of two clouds, in an opposite state of electricity, has been supposed the immediate cause of lightning and thunder; it is not improbable this may sometimes be the case, but it could only occasion *one* explosion. Should two clouds of equal dimensions, and oppositely electrified, be brought within such a distance of each other as to allow them to coalesce, it would occasion a most rapid precipitation of the whole vapour contained in each; for as soon as the electrical equilibrium was restored, the particles of vapour would be no longer kept asunder by natural repulsion; but, on the contrary, would obey the law of cohesive attraction, and produce the phenomenon called the bursting of a cloud. This, when the atmosphere is in a highly electric and vapourous state, during the summer months, is not uncommon.

White, in his history of Selbourne, mentions a remarkable instance of this kind, which happened there on the 5th of June, 1784; the thermometer stood in the morning at 64, at noon at 70, and the barometer $29\frac{6}{10}$°, and the wind north. He observed a previous blue sulphureous mist lying on the hanging woods. About a quarter after two, the storm commenced, moving slowly from north to south; a deluge of rain succeeded, accompanied by hail and convex pieces of ice, three inches in girth, which broke the windows in the houses, and damaged several farms in the vicinity, by the floods which succeeded; and pieces of rock were removed weighing two hundred weight. The extent of the storm appeared to be about seven miles, and though the clouds at a great distance were thin and light, and no storm there in sight or hearing, yet at South Lambeth the air was found strongly electric; for the bells of an electric machine rang repeatedly, and numerous sparks were discharged."

A phenomenon, similar to the above, happened near the town of Bromsgrove, in Worcestershire, in the early part of the summer of 1790, to the great astonishment of the inhabitants, who, after a thunder storm, beheld quite a river flowing down the principal street of the town, and sweeping every thing before it within its reach. A storm of lightning and thunder, attended with repeated explosions, is most satisfactorily explained, by supposing an accumulation of electric matter, produced in the manner already described; when this awful phenomenon is about to take place on a grand scale, the lower stratum of air is generally very calm, and we feel oppressed with a sense of closeness in the atmosphere. The vapour is more condensed, and the sky becomes shortly very dark; the lower surface of the cloud appearing to swell, and light fleecy clouds are seen to float in every direction. We first hear distant rumblings, owing to partial accumulations of electric matter in the principal cloud, or in distant clouds communicating with the principal one. When the charge becomes sufficiently powerful to break through the plate, or stratum of air interposed between the cloud and the earth, the explosions commence; the electric matter assumes the shape of a spherical globe of fire, a great quantity of light is instantly emitted through the surrounding medium, and as it necessarily passes by the most ready conductors, strikes buildings, trees, or whatever it may meet in its course. Every discharge is succeeded by a terrible report, owing to the quantity of air displaced; after several explosions the precipitation of the condensed vapour, deprived of its suspending substance, first begins with a few large drops; these are quickly succeeded by a torrent of rain, which comes down with greater rapidity after each successive flash of lightning. The intensity of the charge being now diminished, the explosions become less frequent, and the rain continues to fall steadily till the cloud is so far lightened as to pass over with the current of air generated by the storm. The electricity of the atmosphere appears in two states of the air, both in clear and cloudy weather; the clear or transparent air contains a great quantity of water in solution; for after continued rains, when evaporation or solution of water in air commences, the barometer is found to rise, from the increased gravity of the superincumbent column of air, loaded with the particles of vapour in solution. Transparent air likewise contains more electricity than a vapourous atmosphere, as the electricity of clouds and thunder storms is owing to partial accumulations, and when they have passed over our heads the electricity of the atmosphere is often so slight as not to be discovered by our ordinary electroscopes; and we are obliged to double the intensity by instruments invented for that purpose, to render the electricity of the air evident to the senses. A clear uniformly transparent atmosphere is almost always *positively* electrified. During a space of fifteen years, Beccaria never observed a serene atmosphere in Italy to be *negatively* electrified, except in *four instances*, and then there was great reason to believe it proceeded from the influence of distant clouds.—*Beccaria on Electricity.*

CHAPTER IV.

Power of Vegetables to deprive Vapour of its Electricity—Experiments to shew the Formation of Rain more fully in the Western and North Western than on the Eastern Sides of this Kingdom—Causes and comparative View.

HAVING endeavoured to shew, that the earth is the grand reservoir of electric matter, and that all bodies, when detached from its surface by mechanical means, or by the process of evaporation, possess an increased capacity for this wonderful substance; I shall now proceed to consider the conducting power of vegetables, which will appear more concerned in producing our clouded atmosphere than any other cause that can be adduced. Physiologists have long remarked the influence of electricity on the growth of vegetables, and have with some reason supposed, that it is essentially concerned, as a principal agent, *in the motion of the sap*; for as vegetables are powerful conductors of electricity, and the circumambient air in which they grow, is perpetually varying the proportion of this substance, they must experience a constant influx or reflux of electric fluid. I was principally led to the consideration of this property of vegetables, by remarking the drops of water on the edges and angular points of the leaves of grass about sun setting, before any general precipitation of nocturnal dew was perceptible; and from observing, that trees and hedges occasioned a precipitation of fog, when attended with a *gentle wind, but not in a calm.* The author of the History of Selborne remarks, " that in heavy fogs, especially on elevated situations, trees are perfect alembics; and no one that has been inattentive to such matters can imagine how much water one tree will distil in a night's time, by condensing the vapours which trickle down the twigs and boughs, so as to make the ground below quite in a float. In Newton lane, October 1775, on a misty day, a particular oak in leaf dropped so fast, that the cart way stood in puddles, and the ruts ran with water, though the ground in general otherwise was dusty. In some of our smaller islands in the West Indies, where there are no rivers or springs, the people are supplied with water merely by the dripping of large tall trees, which, standing in the bosom of a mountain, keep their heads constantly enveloped with fogs and clouds, from which they dispense their kindly, never-ceasing moisture. Trees perspire profusely, condense largely, and check evaporation so much, that woods are always moist, and consequently contribute much to ponds and streams."—*White's History of Selbourne.*

These are important facts, but when he attempts to account for this condensation of vapour, he is at a perfect loss. He observes that trees in leaf should condense more than those that are naked, and evergreens more than deciduous trees; but as the former imbibe more, it is difficult to say which drip most. Those deciduous ones entwined withivy distil most, and evergreens imbibe but little." We will endeavour to explain this. A fog is occasioned by the descent of the cold air from the higher regions mixing with the humid vapours, floating in the lower stratum of air; by condensing them it forms a cloud on the surface of the ground, whose electricity is consequently positive, but of different degrees of intensity; for instance, thus—if the electroscope shews signs of electricity in the middle of a large garden or field, it ceases to do so when brought within six or ten feet of a tree, hedge, or building, owing to the conducting power these possess of drawing off the electricity of the vapour, which comes within the power of attraction. A striking difference is observable in the strength of the electricity discoverable in fogs, when such are attended with a perfect calm or gentle wind, especially in an inclosed country abounding with hedges and trees; the vapour, in the former case, will shew signs of electricity, whenever the electroscope is elevated at some distance from trees; but if there is the least wind to give motion to the vapour, it is made to pass through the interstices of the leaves of trees and hedges: by which means it is deprived of such a considerable portion of its electricity, so that the electroscope will scarcely diverge at all, unless elevated into a higher stratum of the vapour, where the insulation is more effectually preserved.

This important fact, which will account for various phenomena, I have repeatedly verified by experiments. Upon the 15th and 16th days of September, 1805, respectively, there was a very dense fog. On the morning of the 15th it was attended with a perfect calm; the trees and hedges being loaded with dew; but no precipitation of the fog, and the electricity strongly positive; at eight A. M. it began to clear away; and at ten A. M. the sun shone bright, and the day was tolerably fair. On the following morning the fog was equally dense; but, about seven A. M. a gentle wind arose from the south, which, bringing new particles of vapour within the conducting influence of trees and hedges, occasioned a copious fall of the vapour from their leaves and small branches, but no general precipitation occurred; for gravel walks and fallow ground were not apparently wetted, except situated under trees; the electricity was scarcely perceptible even in the centre of a large field.

Upon the twenty-first of September I had an opportunity of trying some experiments on the conducting power of vegetables, from eight till ten o'clock A. M. of that day. There had been rain, the clouds then broke, and at intervals the sun shone strongly; about one P. M. the exhalations from the warm moistened ground began to occasion the clouds to condense and gather into storm; the air was very calm; and at two P. M. observing a dark cloud approaching from the south-east, I elevated a gold leaf electroscope and lamp, but could not discover any signs of electricity till the edge of the cloud was almost vertical over the place of observation; it now opened about half an inch negatively, and continued steady at the point of divergency; the instrument was then brought within ten feet of a tree; the divergency now ceased. It was next elevated under a large spreading willow, the lowest branches of which were at a distance of about twelve to fifteen feet from the instrument; no divergency appeared, but when the electroscope was removed; but when the electroscope was removed to the distance of *twenty feet* from the tree, the electricity was as strong as before. The cloud now seemed almost stationary, and I took the electroscope into the middle of an adjoining field of clover, where it diverged strongly; the gold leaf opening about an inch; but when placed within four feet of the clover sward, there was no divergency. The instrument was then elevated in the middle of a field newly ploughed, where I expected to find the electricity stronger, and my expectation was not disappointed; as the gold leaf then repeatedly struck the sides of the glass tube. It was then held within four feet of the surface of the soil, still shewing signs of electricity, and even when placed on the moist ground the gold leaf opened about an eighth part of an inch; but when brought within eight or ten feet of a tree or *hawthorn fence*, the gold leaf ceased to shew the smallest sign of divergency. A considerable part of the cloud having now passed over the place of observation, a gentle wind was perceptible, and two slight explosions of thunder were heard, the gold leaf giving a start instantly sudden before each explosion; some drops of rain fell, and the electricity changed to a positive state; the cloud then passed off to the S. W. and all signs of electricity in the air quickly disappeared.

An observant traveller informs me, that he has often witnessed this power, which vegetables possess of detaching the electric matter from the surrounding vapour, and by thus condensing it, rendering the ground moist beneath. Amongst numerous instances, he says, the 15th of December, 1805, was a very frosty day; the frost had previously set in suddenly, about two days before, after a long continuance of mild weather. The morning was tolerably clear, and as I passed from Bristol to the village of Leigh, the roads were prodigiously hard, and the signs of the frost every where severe; on my return, about three hours after, the air had become thick though the sun shone, and every part of the Horizon appeared loaded with vapour. The surface of the ground still exhibited no sign of either thaw or falling weather, though near *hedges and trees* the ground was quite wet, as if rain had fallen. If it should be objected, this might have been occasioned by the sun, whose altitude was higher at the time of the second observation, I answer, that this was generally in places where the obliquity of its rays did not reach, and in *warmer* and *more exposed* situations no signs of thaw were visible. Further, the power of vegetables to attract vapour or to condense it by detaching its electricity, when it is either greater or less than that of the earth, is agreeably evident to our senses in some parts of winter, when the cold is so great as to congeal the vapour into that state denominated *Rime*, which if there be the least wind or current of air to waft it, is attracted by the adjacent trees and hedges; and assumes, by the variety of grotesque-figurative lines, it forms, a beautiful appearance to the beholder, which powerfully arrests his attention in defiance of the cold which urges him to proceed.

These effects are not related as *uncommon*, the same having been frequently observed by electricians and travellers. I merely mention them to shew those unacquainted with the subject, the great influence living vegetables possess in rendering the air, in their immediate vicinity, of the same electric state as the earth. Since the conducting power of vegetables is essentially connected with the theory I have formed for elucidating the phenomena of the weather, more especially in this Island, so remarkable for the growth of trees and shrubs, I shall describe a few experiments performed with electricity excited by *Art for the purpose.*

Experiment 1*st.*—An electrical cylinder being strongly excited, and the prime conductor charged, a gold leaf electroscope was placed on a table within four feet seven inches of the conductor; the gold leaf diverged an eighth part of an inch: it was then removed to a distance of five feet seven inches from the conductor, when no divergency appeared.

Experiment 2d.—A small brass wire, three inches long, and terminating in a point, was placed erect on the cap of the electroscope, the distance of four feet from the conductor, it diverged an eighth part of an inch; at five feet seven inches there was no divergency, but when brought within fourteen inches of the prime conductor, the gold leaf struck the sides of the tube.

Experiment 3d.—A small branch of willow fourteen inches long, with its leaves, about twenty in number, was placed erect on the cap of the electroscope, which, at four feet seven inches, diverged one-fourth part of an inch; and at five feet seven inches, an eighth part of an inch.

Experiment 4th.—A similar branch of willow, containing as many leaves as the former, was now placed erect on the charged conductor, the electroscope, with its cap and branch, was removed to the distance of eight feet, the gold leaf opened, and struck the sides; and, at the distance of twelve feet, diverged a quarter of an inch.

Experiment 5th.—Three full ears of barley, with *their awn* in the state in which *they* grew, were placed erect on the conductor instead of the branch of willow; the divergency was the same as in the last experiment; but when the *awn* was removed from the ears of the barley, the divergency was considerably less; the gold leaf did not strike the sides of the electroscope, until it was brought within *six feet* of the charged conductor*.

Experiment 6th.—The leaves were now removed from the branch on the prime conductor, and from that on the electroscope; the gold leaf now did not strike the sides, until it was brought within six feet of the conductor, and at twelve feet distance there was no divergency.

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* It appears from this experiment, that the *awns* of barley, wheat, rye, and other *aristiferous* plants, are meant as beneficial auxiliaries, or conductors of electric matter for the maturation of the seed; and hairs probably perform a similar kind office on the leaves of *hirsute* vegetables. A set of experiments to shew how far depriving some plants of hairs, and others of their awns, would affect the growth of the one, or the perfecting seed in the other, would be a valuable addition to our physiologic knowledge. This may be corroborated by an experiment, often tried with the similar success, of immersing a dry hairy leaf in water just drawn from a spring or pump, which contains a quantity of air; innumerable globules appear instantly on every point;—the extremities of these points attract the particles of water less forcibly than those particles attract each other; hence the contained or latent air, whose electricity was but just balanced by the attractive power of the surrounding particles of water to each other, finds, at the point of each hair or fibre, the resistance to its expansion less; it consequently expands, and becomes a *bubble*. The rays of the sun being partly refracted, and partly reflected, by the surfaces of these minute bubbles, must impart to them more heat than the transparent water, and thus facilitate their ascent by a further expansion. And that the points of vegetables attract the particles of water less than they attract each other, is evident from the spherical form of the dew-drops before alluded to, frequently visible in the evening on the points of grass.

From experiments of this nature, the great power which vegetables have in depriving floating vapour of its Electricity is evident to the senses, though it does not appear that their influence extends to any great distance; in a room, the electroscope was seldom made to diverge beyond *twelve feet distance* from the charged conductor, though a green branch was affixed to both; and in the atmospheric experiments I observed, that trees and hedges did not rob the air of its electricity *beyond the same extent.* This accounts for the precipitation of vapour, when mechanically brought near to the leaves of vegetables by winds, as observed on the 16th of September. Thus we find that when a country is much crowded with trees and herbaceous plants, not only a larger quantity of moist vapour is afforded to the atmosphere, but a portion of the electricity is reabsorbed, and the sun has consequently less power, owing to this absorption to dissipate the vapour, and render it transparent by dissolving it in air; so that this reduced quantity of electric matter probably may, or rather I should say, actually does, occasion partial accumulations of cloud, and consequently storms attended with lightning and thunder. If proof should be required of the sun's power of dissolving strongly electrified vapour into transparent air, we would request our readers to observe frequently its powerful effects in perfectly dissipating the summer Autumnal fogs, during the short space of two or three hours, and the reverse that takes place in the months of November and December: when his rays are more oblique and weak, and the conducting power of vegetation less. The following very satisfactory experiment was made to shew the influence of vegetables in seizing the electricity of rising vapour, when brought within their conducting influence. To the cup of a gold leaf electroscope I affixed a horizontal support for a candle, which projected two feet from the cap of the instrument, placed near the edge of a table; on the floor immediately below was an earthen vessel containing hot water about one inch in depth; the candle being lighted, two or three red hot embers were dropped into the vessel of water, which instantly raised a sudden cloud of vapour; the Electricity of this being collected by the candle connected with the electroscope, the gold leaf opened suddenly, and struck the sides positively. Some branches of trees, with their foliage, were now placed between the vessel on the floor and the candle; the experiment being repeated, the vapour passed through the interstices of the boughs, but the electroscope opened only half an inch; more boughs were now added, and slightly sprinkled with water to increase their conducting power; the experiment was again repeated; a great part of the vapour still made its way through the interstices of the leaves and branches, *but so completely deprived of its electricity, that the gold leaf did not diverge in the smallest degree.* This very satisfactorily accounts for the clouded atmosphere, which is found generally to prevail over countries covered with luxuriant herbage, or extensive woods; and not only do countries whose surfaces abound with rich herbage or covered with extensive forests, but mountainous districts also experience a more humid and cloudy atmosphere than those whose surface is more champaigne.

The conical tops and high ridges of mountains, especially if covered with wood or herbage, are perpetually attracting a portion of the electric matter from the vapour, and consequently disposing it to form clouds and storms. With a view to shew the influence of such mountains, whose tops are covered with verdure, in depriving vapour of its electricity, I tried the following experiment:—Upon the cap of an electroscope was placed a conical shaped pebble, whose height was two and a half, and diameter two inches; the instrument was then brought within eight feet distance of the prime conductor of an electrical machine, on which was placed a pointed wire three inches long, to diffuse the electricity about the room. The gold leaf of the electroscope diverged half an inch, but when removed to twelve feet distance, it did not diverge at all. Some short moss was then placed upon the upper surface of the pebble; the gold leaf of the electroscope then struck the sides of the tube at ten feet distance from the conductor, and diverged a quarter of an inch at the distance of twelve feet. In these experiments, the conical-shaped pebble was intended to represent the summit of a mountain devoid of verdure, and the charged conductor of the machine and atmosphere of the room, an electrified cloud. But by clothing the stone with moss, the conducting surface of the pebble was increased, and consequently, like a mountain covered with verdure, drew off a larger portion of electricity from the surrounding medium. This is one cause why a mountainous country is more subject to rain than such whose surface is flat, or inclines to a level. The insulation of aqueous vapour, arising from the surface of the sea, being more effectually preserved than that which arises from the land; especially if this last is covered with a luxurious vegetation. And it would probably appear if a ship were stationed in a given latitude, at a considerable distance from shore, to ascertain the fact, that a less quantity of rain would be found to fall annually on the *Sea* than on the same parallel of latitude on *Land*. This appears highly probable from the southern part of England near the Sea, though they have frequent scuds of rain, yet they have a less average quantity fall annually than in more inland parts of the country; and Dr. Barry, in his history of the Orkney Isles, observes that, surrounded by seas, and intersected and divided by numerous friths, yet the average annual depth of rain in those islands does not exceed *twenty-six inches*.

White, in his History of Selbourne, in accounting for some perennial ponds on the highest parts of the Chalk downs, observes, "That the evaporating power is more prevalent in bottoms or vales than on hills; but at the same time supposes they are recruited by nightly dews, which countervail this loss by cattle during the day. And he justly adds, that persons who are much abroad during the night, such as shepherds, poachers, &c. can tell what prodigious fogs prevail in the night on elevated downs, even in the hotest parts of summer, and how much the surfaces of things are drenched by those swimming vapours, though to the senses little moisture seems to fall. But how does he account for it? Dr. Hales, in his Vegetable Statics, vol. 1st. advances from experiment, that the moister the Earth is, the more dew falls on it in a night, and more than a double quantity of dew falls on a given surface of water than on a given surface of moist earth; and hence infers that water, by its coolness, is enabled to assimilate to itself a larger quantity of moisture nightly by condensation." But, with deference to both, we can prove that the evaporation from a given surface of water, during a hot day, is much greater than the quantity of dew which falls during the most condensing night; and that as the sea water is saturated with electric matter, it draws off less from the circumambient vapour than *the vegetable surface of Land.*

There is reason to believe, that the mountainous tract of country which extends the whole length of our western coast, from Cornwall to the north of Scotland, and continues in the same direction through Orkney and Shetland, has a considerable influence on our climate; for this elevated conducting surface must draw off much of the electric matter from the warm humid air of the great western ocean by our most prevailing winds, the west and south-west; and this disposes the clouds to precipitate their moisture on their entrance, more than during their future passage over the Island. The great proportion of rain which falls in the *north western* coast, compared with counties situated on the *south eastern* side of the Island, is probably caused by its vicinity to North Wales and Ireland; the humid south-west wind experienced in Lancashire and Westmoreland, passes first over the mountainous tract of North Wales, where the clouds are deprived of such a portion of their electricity, that the contained vapour is precipitated in torrents. Further, when the wind veers more to the westward, the vapour, before its arrival here, passes over Ireland, the climate of which being naturally humid, and the clouds passing over so short a portion of sea the disposition of the air is scarcely changed; so that when the Wind is in any westerly point, the inhabitants of Lancashire and Westmoreland will seldom have cause to complain either of intolerable and long-continued drought, or of their lands suffering for want of atmospheric Irrigation. The proportion of rain which fell in the course of a year, at Townly, in Lancashire, was measured a century ago, and, compared with the quantity which fell during the same space of time, at Upminster, in Essex, stood thus:

"Townly.... 42½ inches—An average of six years.
Upminster.. 19¼ do.—From 1700 to 1705 inclusive.

The mean quantity of Rain which has been observed to fall in the county of Rutland, in the east, is twenty inches and a half. This very large proportion of Rain, which the county of Lancaster receives; compared with Essex, is probably occasioned by the above-mentioned local circumstance; for we cannot rationally suppose, that the soil of the county of Lancaster requires this extraordinary degree of Irrigation, the latitude of this county being three degrees more to the north than that of Essex. To shew the difference between a flat open country and one less open and hilly, take the following account of Rain, which fell at Selbourne, Hants, in the same eastern parallel to Essex:

1780, 27.37½ inches——1784, 33.80 inches
1781, 30.71 do. ——1785, 31.55 do.
1782, 50.26½ do. ——1786, 39.57 do.
1783, 33.71 do.

The mean quantity of which is 36.98 inches annually.

Dr. Hales observes, that the average quantity which falls in England is about twenty-two inches. If we make a comparison with the southern part of the kingdom, where, from the vicinity to the sea, and the influence of south-west winds, more might be expected, we shall find less than the western and north western, and even than in some interior districts; for Dr. Huxham, in Observations de Acra, containing an account of weather from 1727 to 1748 inclusive, remarks, "That the Rains are frequent on the coast of Devon, yet the average annual fall is not great, and some years comparatively small. In 1731, the guage measure was seventeen inches two hundred and sixty-six tenths; 1741, twenty inches three hundred and fifty-four tenths; 1743, twenty inches nine hundred and eight tenths; in a very wet year, he found it thirty-six inches; and once, 1734, thirty-seven inches one hundred and fourteen tenths. Frequent small Rains, he observes, keep the air moist, while heavy ones render it drier, by beating down vapours. Is the dingy appearance perceivable in hot weather, he says, owing to a want of moisture to make the atmosphere transparent, since some bodies are more diaphanous in a wet than a dry state? The following comparison between four places situated in different parts of the kingdom, appear in a meteorological journal kept by Major Rooke of the quantity of rain which fell at the following places in the year 1798 :—

London, Middlesex................	26.22 inches.
West Bridgeford, Nottinghamshire	27.22 do.
Lancaster, Lancashire...............	48.19 do.
Kendal, Westmoreland	60.85 do.

Though it may appear to a casual observer, that there is less of that wonderful regularity in the phenomena of the weather, which we are accustomed to admire in the other works of the creation, still we shall find a system for regulating this process; and the quantity of rain which annually falls upon the earth's surface, will in general be found, where local circumstances do not interfere, proportioned to the degree of heat which the soil receives from the solar rays. The great excess of rain observable at Brecon, on a comparison with a London meteorological journal, may be easily accounted for by the vicinity of Brecon to the southern range of hills, and particularly to the Bannau Brecheiniog. The great height of the beacons frequently intercepts the clouds, charged with watery particles, in their passage from the south or south-west, from whence the rainy wind generally blows; thus separated or dispersed, they descend in rain; and it must be admitted, that when these mountains are covered with snow, we occasionally feel

> "The icy fang
> And churlish chiding of the winter's wind,
> Which bites and blows upon our bodies,
> Ev'n till we shrink with cold."

The following is the quantity of rain, which fell in London and Brecon in the year 1802:

London, 15.12 inches——Brecon, 26.25 inches.

Vid. Jones's Hist. of Brecon.

We find, on a comparison made a century

ago, between the state of weather, at Upminster, in Essex, and at Paris, that the latter, upon an average of six years, experienced the most rain; the annual proportion of each place, calculated for the given term, was, Upminster, nineteen inches, and Paris, twenty inches.—*Vid. Derham Phys. Theol.*

The following numbers shew what were the annual depths, but without taking the average, at

Lisle, in Flanders	24	inches.
Zurich, Switzerland	32¼	
Pisa, Italy	43¼	
Barbadoes, West Indies	67	
Sierra Leone, Africa	86	

And if we possessed accurate registers of the quantity of rain which annually falls in different latitudes, there is little doubt but we should find it nearly in proportion to the evaporation caused by the solar heat; allowances being made for sandy deserts, where, of course, there can be little exhalation, or conducting surface, to destroy the insulation of the vapour.

Wherever the surface of the earth is devoid of vegetables, or water, as is the case in most arid deserts, especially those situate to the south of the temperate zone, the atmosphere is generally clear, and strongly electrified. Mr. Brydone observed, in the course of his tour through Sicily and Malta, when he visited mount Ætna, around which there is much dry land occasioned by the dispersed lava, the air was highly electrical; but up the sides of the mountain, where vegetation was very luxuriant, the electricity of the air was little, and in some places it was quite, imperceptible.

CHAPTER V.

The different Effects produced by a settled and serene, or a moist and cloudy Atmosphere, on Vegetable and Animal Economy—Diseases of Plants, arising from the sudden Variations of Temperature—Increase of noxious Insects—Kinds discovered which were formerly unknown in this Climate.

AFTER this long digression, we will return to our more immediate subject, and proceed to consider the probable effects of a more settled and serene, or *cold and cloudy* atmosphere upon the animal and vegetable economy of our Island. I confess when I first read Malmsbury's delicious description of the vale of Glocester, written about the middle of the twelfth century, I felt much disposed to question the fidelity of the learned Monk's picture; but since I have directed my attention to the subject of the present enquiry, and reflected on the effects of the extraordinary changes which the surface of the country has undergone since that period; I am more inclined to admit the truth of his testimony. When William of Malmsbury wrote, eleven centuries had elapsed from the time that agriculture had been introduced into Britain by the Romans. The climate had therefore been gradually improving, by the vales being considerably cleared of their woods, to make room for the operations of the plough; but the population was not then so great as to require the cultivation of the higher grounds; these would, therefore, be left in a state of nature, to afford pasturage for their sheep and cattle: and as no scarcity of timber could have yet occurred, there is no necessity for supposing the *general* introduction of the elm, the ash, the sycamore, chesnut, and other exotic timber trees of more rapid growth. The venerable oak had then no foreign intruder to dispute the benign influences of the heavens; nor was its atmosphere then polluted by their humid exhalations. The esculent fruits of the Icosandria class, too, at that time, experienced what their nature seems particularly to require, a dry state of the air during the period of their bloom, without which the setting of the fruit becomes very precarious; owing to the pollen, or fructifying powder, contained in the anthers being too much diluted, or washed off by heavy rains. Nature seems to have been particularly careful in this respect; for we find the season of bloom generally to arrive previous to the protrusion of the vernal leaves; so that there might be nothing to intercept the solar rays, and prevent them from falling on the points of fructification; by this means, the mischiefs whic would otherwise arise from a vapourous atmosphere, are effectually counteracted*.

* Of all the propensities of plants, none seem at first more unaccountable *than the different seasons in which their blossoms appear;* some produce their flowers in the winter, as the Christmas rose, Helleborus niger; others before the sun is gone in February, as the elegant snow-drop, Galanthus nivalis; in March, the crocus, Crocus satirus; in April, the sweet-scented violet, Viola adorata, peeping through the thorn; and in May the cowslip, Primula officinalis, perfumes our meads; and June is crowned with all the varieties of the unrivalled rose. Thus, through the varying year, till after most plants have formed their seeds, fade and decay, appears the beautiful *leafless* flower, the winter crocus, Crocus autumnalis. This circumstance is among the thousand wonders of creation, and is little noticed because a common occurrence, yet ought not to pass by unobserved; for it would perhaps be as difficult satisfactorily to explain it, as the most rare or stupendous phenomena in the cours of nature.

> "Say what impels, amidst surrounding snow
> Congeal'd, the crocus flamy bud to glow?
> Say what retards, amidst the summer's blaze
> The autumnal bulb, 'til pale declining days?
> The God of Seasons—whose pervading pow'r
> Controuls the sun, or sheds the fleecy show'r;
> He bids each flow'r his quick'ning word obey,
> Or to each ling'ring bloom enjoins delay."
>
> DARWIN.

A dry state of the air, during the flowering season, seems to be a matter of great importance, not only in the case of fruit trees, but throughout the vegetable world; as we find that wheat never yields well, if there be much rain or wind during the time of bloom. The same remark is made in countries where the vine is cultivated; for if cold rains, remarks Mr. Arnoux, happen during the period when the blossoms of the vine turn into berry, they experience blight and fall off; and those berries that do set, are very small, and almost always destitute of seeds. Fogs or rains, at this period, are destructive to the blossoms, and do essential hurt to the grapes; besides the putrid miasmata, which they frequently deposit on the production of the fields, they are always attended with the inconvenience of moistening the surfaces, and of forming on them a humid stratum, more subject to evaporation, as the interior of the plant and the earth are not moistened in the same proportion; so that the rays of the sun falling upon this light stratum of moisture, causes it to evaporate instantly, and the cold, produced by this evaporation, is succeeded by a heat, the more prejudicial, as the transition is more sudden.—*Vid. Chaptal on the Vine.*

Cold winds, at this season, are also highly prejudicial to the setting of the fruit, not only by too strongly dissipating the fecundating powder of the anthers, and by also drying and constringing the branches through which the necessary juices flow; but producing on strong lands a tenacity in the soil, which deprives the roots of the power of performing their essential functions; orchards and vineyards should therefore be planted in *sheltered situations.* The same remark may with propriety be extended to almost every vegetable that has yet come under our observation. The early flowering esculent fruits, cultivated in this country, have suffered of late years most severely, during the period of their bloom; so that three years out of five, we have been partially or totally deprived of their expected produce*. The apples and pears suffer most from the inclemency of the seasons in *April* and *May*. The apples in the county of Worcester were chiefly cut off for two successive years, 1803 and 1804, by a frost which happened in both seasons, on the same night of the latter, *the 16th of May*. In 1805, the crop in Worcestershire was again nearly destroyed by frosty nights following after showery days; the severe frost, which happened in the night preceding the 30th of April, did great damage; for this was succeeded, in the beginning of May, by storms of hail and rain, attended by very cold nights. A showery moist spring, too, seems much to favour the hatching of the eggs of the different species of Phalœnæ, Papilio, Aphis, Coccus, Ichneumon, and other destructive insects. We invariably find, if there has been much rain during the month of May, that the hawthorn fences are covered with caterpillars, but not so if the prevailing weather at this season has been dry. This observation I have made for a number of years. A curious instance, illustrative of this fact, occurred in the month

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* The failure of crops of the common fruits is a serious evil to the community in many points of view; sub-acid fruits, which abound in the summer and autumn, when the heats are greatest, appear as necessary for the human species, as green fodder for the granivorous classes of animals. It is not my province to account for this salutiferous influence on the animal economy, by entering into a description of the alkaline accumulations produced by the free use of animal food, and other causes, or in what way the juices of fruits, by neutralizing these, prevent fevers, biliary complaints; and many cachexies of the system; besides, it has been already done by abler pens: it is, however, appropriate to remark, that artisans and labourers in the confined manufactories of large towns, suffer prodigiously in their

health, in seasons, when there is a failure in the crops of common fruits. A gentleman, on whose judgment and veracity I can rely, informed me, that the labouring classes suffered much in their general health from a scarcity of common fruit during last year, 1804, and the failure again, 1805, was attended with similar effects.

of June, 1799, when the caterpillars of the Papilio antiope were prodigiously numerous in most of the hawthorn fences in the neighbourhood. I observed their progress upon a young healthy fence, on the eastern boundary of a kitchen garden; by the second week in June, they had completely devoured the whole of the foliage, leaving the stems as bare as they appear in the midst of winter. Within this fence there was planted a hedge-row of the Prunus laurocerasus, or common laurel; upon this these depredators, constrained by imperious necessity to remove their quarters in quest of food, commenced their attacks; and from what has been advanced, of an infusion or decoction of laurel leaves as a liquor to destroy insects, I now concluded they would all be poisoned by the change to this deleterious diet: but, to my great astonishment, they continued to thrive, and, by the nourishment the evergreens afforded, or the superlative supply before obtained from the hawthorn, they arrived at maturity, and attained their more enviable state of butterfly. The caterpillar and aphis, it has been remarked, are more injurious to the apple trees than frost. The eggs of the Papilio, and Phalœna, as well as those of the Aphis, are said to be deposited the previous autumn, near the buds of the tree; for when they are first hatched, they are so exceedingly small, as scarcely to be discovered by the naked eye; and their motion is so slow, that it is not probable they would in this state be able to ascend the trunk of the trees. White observes, that August 1st, 1785, about three o'clock in the afternoon of that day, which was uncommonly hot, the people were alarmed by a shower of aphides, or small flies, which fell at the village of Selbourne. Persons walking in the streets at the time, found themselves covered with insects, they also settled on the hedges and gardens, blackening all the gardens where they alighted. These entomological armies, on such occasions, appear to be shifting their quarters, and, in this case, probably emigrated from the hop plantations in Kent; the wind at this time blowing from the east, they were, he says, observed in great quantities about Farnham, and in clouds through the whole vale, from Farnham to Alton.

The destruction committed by the different species of the genus aphis, every year, in the spring and early part of the summer months, is truly astonishing. Exotic trees and shrubs are generally attacked first; but the depredations of this active tribe of insects are not limited to these; the "brawny oak" is oftentimes as much infected as the most delicate rose. Dr. Darwin has given a long and very interesting account of these singular insects in his Phytologia. In fact, every person at all interested in agriculture or gardening, must have noticed the miserable havoc they make in our gardens, orchards, and hop grounds. It is a generally received opinion, that they are produced from eggs, deposited the previous autumn in parts of the plants on which they are found; while others suppose that they are brought by particular winds from distant places. They are said to be the cause of the dire disease of vegetables, called *honey dew*; but this disease I conceive to be owing chiefly *to those sudden variations of temperature, to which our Island is at present continually so subject.* In the months of April, May, and June, if we get a few hours or days of bright sun, the thermometer will rise as high as in the south of France, or even Italy; this heat is frequently succeeded, with us, by frosty or very cold nights, and perhaps the next day or two is followed by hailstones, or cold, cloudy weather. The living principle, or excitability of the plant, is in the first instance thrown into great action, during the continuance of the stimulus of heat; and this being suddenly withdrawn, a torpor succeeds; the circulation of the juices in the finer vessels of the leaves and tender shoots is obstructed, while the absorbent vessels of the roots, by the assistance of the contractile power of the outward ring of liqueous fibre not having received injury, continue to propel the rising sap, which arriving at the injured leaves and young terminal shoots, the proper secretions and excretions are here intercepted, new materials, and new vessels are produced. This process is very analogous to diseased action in animal life; when our extremities are exposed to great degrees of cold, a local and temporary torpor is the consequence; but as the heart, like the trunk and root of trees, is not injured, this organ propels the blood to the injured part, where, meeting with obstructions, inflammation, with the consequent production of new vessels and new secretions, succeeds. The saccharine gummy substance, frequently observable on the diseased foliage of plants, more especially of trees in the spring and early part of summer, is called *Honey Dew*, from its sweet taste resembling the substance designated by the *first term*; and the *latter*, expressive of the mode in which it is supposed to make its appearance. But both terms convey an erroneous idea; as some are led to think, that during night a shower of mellifluous fluid falls on the leaves; and this absurd opinion is not yet obliterated: but were this the case, on these occasions the gravel walks of gardens and other shrubs and plants contiguous to those affected, would be covered also. It is evidently owing to a diseased state of the vegetable absorbent vessels, which thus deposit the juice in question on the leaves, and is properly termed "*exudatio mellita*." In the sultry season of 1783, says White, *honey dews* were so frequent as to destroy and deface the beauties of my garden; my honeysuckles, which were one week the most sweet and lovely objects the eye could behold, the next became the most loathsome, being inveloped in a viscous substance, and loaded with *smother flies*.

The occasion of this clammy substance seems to be this: In the hot weather, the effluvia of flowers in fields, &c. are drawn up in the day, by a brisk evaporation, and, in the night, fall down with the dews in which they are entangled. That the air is strongly scented, our senses inform us; and that the clammy substance is of a *vegetable nature*, we learn from bees, to whom it is highly grateful. That it falls during the night is evident, from being seen first only in warm still mornings. This exudation is most frequently occasioned by the causes here assigned; but we have reason to think, that the evil sometimes arises from another quarter. No plantations are so subject to be infested with these insects as *hop-yards* or *hop-grounds*; and when other kinds of plantations, usually liable to their depredations in the same aspects, and, in similar seasons, have escaped; these have been observed almost devoured. On enquiring into this phenomenon, I have invariably found that it proceeded, *first*, from the attack of numerous grubs, or caterpillars of the Phælæna humuli, or *otter moth*, devouring the tender fibres of the roots. The plants, deprived of these functionaries, at a time they most want their assistance, sicken, the motion of the absorbents becomes retrograde, the juice called honey-dew spreads over the surface of the leaves, on which the aphides find both asylum and food; and the plants, attacked above and beneath, soon fall a prey, and wither away. Some, however, think those insects are the *cause* of this disease, and that they proceed from eggs deposited on the plants the preceding autumn, and are hatched on them; others, that they are brought by certain winds; but if they were, all trees liable to their depredations, when growing in the open air in the vicinity of their arrival, would be equally injured by them; and that they are not so, if the sudden variations in temperature are guarded against, will appear from the following facts. Ninety feet in length of a south wall in my garden are built with flues for conveying heat in ungenial weather; three peach, and two nectarine trees, are trained against this wall. The last two seasons, 1804 and 1805, a fire was made whenever the night was calm, and consequently a frost expected;

but no artificial heat was given in the day, unless a storm of snow fell, or very unfavourable weather happened. This plan was uniformly pursued from the time the blossoms first opened in the month of April, till near the end of May. Both seasons the trees set unusually well, and an abundant crop of fruit resulted from this management. Indeed so abundant was it, that two-thirds at least were obliged to be removed, to secure and ameliorate the rest; yet not an aphis appeared, nor was a single leaf curled during either of the seasons, from the time the foliage opened in the spring, till the fall of the leaf in the end of autumn. At the same time every peach and nectarine in my garden, exposed to the casualties of the weather, were both years miserably infested with the Aphides. The inference is so obvious as scarcely to require comment; for if the Aphides were brought by the winds, those against the *warmed wall* would have been equally as liable to their depredations, as the other trees in the garden. That the eggs might have been previously deposited on the *buds* or *bark* of these trees, there can be little reason to doubt; for analogy makes it highly probable, and the indefatigable researches of Reaumer, place the matter beyond the region of ambiguity; but it is satisfactorily proved that heat, without a considerable degree of moisture, proves fatal to most insects in their embryo state; and this fact may furnish a *useful hint* to gardeners, orchardists, and agriculturists. However, there can be no doubt at all but the respective species are first generated on particular species of plants, and, after the eggs are deposited, are there hatched, and from thence propagated to infest similar plants, till they become, from necessity, irregular in their habits, and desultory in their movements. How, many species of the *Hemipterous order* of insects contrive to emigrate from place to place is a matter worthy of investigation; on this subject we have had but very slight information. Do they possess bodies, like the small spider, which darts out his web, and raises himself to great heights in the atmosphere, forming those numerous filmy clouds which we call *gossamer* in our fine autumnal days? Or have they some other method of rendering their bodies lighter than air, of becoming buoyant, and shifting their quarters, by taking advantage of favourable winds? That they do emigrate, and to great distances, is an obvious fact; and what favours this idea is, that the Aphides all differ in shape, size, and colour, according to the plants on which they are found to thrive. If we minutely examine the species of Aphis found on the terminal shoots of the gooseberry, we shall find it different to that on the currant*;—again, those on the peach differ in colour from such as infest the cherry, the former being of a *green*, and the latter *black*; upon the variegated elder, they are blue; on the sycamore grey; on some plants they appear transparent, and on others opaque; sometimes they are found with hairs on the body, and at others with a scaly shell; but their general habits appear to be universally the same. They are principally found on the under surfaces of the leaves, and on the ends of the tender shoots, where they puncture the vessels with their proboscis, and rob the plants of the descending sap which has been prepared in the leaf, and is proceeding to its various destination, for the increase of the vegetable; its root, fruit, ligneous and cuticular fibre, the different secretions, and the formation of germs for the propagation of its species. As the bark of the shoot becomes more firm and hard by exposure to the sun and air, the Aphis is unable to puncture the cuticle; so that we only find them on the leaf and the ends of growing shoots. The necessary progress of the sap, through the different vessels of the leaves, is often impeded by a warm humid state of the atmosphere; this will often produce the *exudatio mellita*, or honey dew before mentioned; and it is proper to observe, that plants are more subject to diseases, and the depredations of insects, when deprived of *sufficient ventilation.*

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* It is, however, mentioned by Linneus, that the insect which infests both is but one species, the Aphis grossularia; and the difference observable arises only from these two nearly allied plants on which they feed.

To ascertain so important a fact, I had recourse to the following experiment: I took two cuttings of the *Chinese rose*, a plant generally propogated and retained in our conservatories. The cuttings were perfectly free from the Aphides when taken from the plant, but before they were planted, I took the precaution to wash them, one in lime-water, and the other in a different alkaline ley; and, upon examining them with a strong magnifying lens, there did not appear the least sign of any eggs of insects. They were then planted in separate pots, and covered with double glasses inverted, to exclude all communication with the external air; assisted by the genial warmth of a hot-bed, they struck, and began to grow; but, in a fortnight's time, they were covered with Aphides. It might have been concluded, that these insects were generated on the *plants themselves*; but it has been observed by some that, in their early state, they are so minute as to be included in the *very pores*, and, with the strongest lenses, only appear to form a part of the plant. However, it clearly proves, that sudden heat, accompanied by moisture, facilitates their developement: which accounts for their immense increase in humid close weather. An attentive observer may often see the wonderful instinct of these minute parts of animal creation for the continuation of their respective kinds; several species of Coccus, Aphis, and Phalæna, may justly be termed *mining insects*; they provide themselves shelter from enemies and the weather, by perforating the parenchyma of the leaf, as miners do in the earth. Intolerant of exposure in this state, or desirous of securing their future progeny, they insinuate themselves between the two foldings of a leaf, or the cuticle and epidermis of the bark; the inclosed parenchyma, or sap, affording them food. Owing to these insinuating marauders, you will frequently discover the leaves covered with blisters, or pulpy leaves, gradually growing thinner, till there is no celular substance left; and the leaves, thus deprived of their circulating juices, drop from the trees. How often do we see the leaves of vines pierced with innumerable small *oval holes*, as if made with a small gimlet; these are occasioned by mining Papiliones, which, stripping two pieces of the leaf, form themselves cones for habitations, which they generally affix on the branches or vine props: sometimes they form a *gallery* in the leaf, and place the cone at the farther end of it. Thus secured, they continue to draw resources from the vegetable, till they are metamorphosed into their respective butterflies. Our knowledge is extremely bounded on this very important subject; when we possess more light, we shall cease to wonder at the mischiefs known to proceed *from Insects.* The Coccus is another genus containing numerous species of the destructive order Hemiptera, whose males have wings, and the females none; when full grown; they have the appearance of a boat with the keel turned uppermost; they attach themselves to peaches, nectarines, apples, pears, and, lately, they have been discovered on *wheat plants*; on all which they often make sad havoc: these attack generally the bark, as the Aphides do the leaves of trees. A thin *film, or cotton-like substance, is interposed between the body and the tree.* In their grown state they resemble small excrescences on the bark, through which they penetrate, and the trees appear as if they had been scratched by the claws of some animal; canker follows their attack, and the death of the tree generally ensues.

Of this genus a *new species* has lately made its appearance, and, by accounts from different quarters, seems to be alarmingly spreading through the kingdom. It was first observed to infest the *apple trees* in nurseries and gardens about London nearly seventeen years ago. Many nurserymen lost, by this apparently despicable *marauder*, several thousand *trees in one year.* It was observed to be prevalent through the orchards in Kent, and, since that time, in various parts of the kingdom. Three years ago it first made its appearance in the gardens near the city of Worcester, and is likely to become a pest to the extensive orchards in that and the adjoining district; for they appear to possess a considerable power as well as inclination *for emigration.* They make their nests generally where branches have been cut off, or where the canker has eaten holes; their first appearance is like *white film or down*; they then appear of the size of the Aphis pomus, or Aphis which infests plumbs and peaches, of a dark bluish colour, and when rubbed between the fingers give a red stain; they are found in the small cavities of the trunk, and the under side of the smaller shoots; they puncture the bark, which is followed by small warts or knobs; the trees become sickly, and soon die; for wherever they attach themselves, they rob the trees of the descending sap, and deprive them of their necessary nourishment. They are supposed to have been brought from America in some apple trees imported by the late Mr. Swinton. It does not appear that they are peculiar to the *apple*; for apple trees were first taken to America from Europe; and, from the most accurate enquiries, Sir Joseph Banks informs us, that the orchards in France do not appear to be acquainted with this enemy to Pomona. If this be the case, the importation of new varieties or species of trees, becomes a serious consideration; more especially because those climes abound in noxious insects; and it would be proper to oblige all such articles of import, to undergo a kind of quarantine, that they might be exposed to a fumigation, which might destroy any eggs or larva, &c. of insects; otherwise the evil, by increasing, may extend to an alarming height; for if *their* increase should at all be equal to that of the kindred tribe, the Aphis; they may, with the united operations of others, increase so as to destroy an important part of vegetation. Many species of the *acarus*, also of late years have been observed to increase prodigiously; not confined, as formerly, to the melon frame, or the grapery, but seriously infesting many of our valuable fruit trees; and though they are destitute of wings, yet they possess the power of *emigration.*

We might adduce proofs of the multiplication of *many other kinds of insects injurious to plants*; but the subject would far exceed our limits. The description of noxious insects, their methods of infesting animal and vegetable nature, with the best means of destroying them, or preventing their increase, would become an interesting work. We have cited these instances only to shew, that they have been multiplying rapidly within these few years; and thus as heat and moisture are essential to their existence, and favourable to their developement, it follows, that the *Climate of England has been evidently changing*; and that the state of our atmosphere, at the seasons these insects generally make their appearance, must be more close and humid than formerly it was.

From the atmosphere, congenial to many of these insects, being of a moist nature, the inefficiency of the plan of *frequent irrigating trees*, &c. on which they are found, will instantly appear; for if the weather be hot, this tends to increase the malady, and if it should be cold, the trees will infallibly be materially injured. Mr. Forsythe states, that he has extirpated the Cocci from his Majesty's gardens at Kensington; and recommends scraping the bark with a piece of bone, or board, and then washing the trees with an equal mixture of soap suds and urine. The same mixture he advises to be sprinkled over plants and trees, with a watering-pot and rose, for the destruction of the Aphides. The application of oil with a brush to the bark, as practised by the farmers in Kent, is found pernicious to the trees; for, by closing the pores, it is apt to make trees become what is termed bark bound. A permanent remedy for this evil I fear will never be discovered, unless we can prevent the sudden variations of temperature to which our plantations are so continually exposed. This variableness probably may be diminished by reducing the unnecessary evaporating surface, and, by this means, reducing the quantity of clouds; thus the soil will become warmer and drier, which will contribute to moderate the cold air in the spring that descends upon us in calm nights. This is the case in the autumnal months, when the Earth and Sea have been heated by the long continuance of the sun in our northern hemisphere; for we find our vegetables, at this season, free from the Aphides; and, by comparing the range of the thermometer an hour before sun-rise, which is the coldest part of the twenty-four hours, we observe it to stand much higher at this season, than in spring; that is, in July, August, and September; than in April, May, and June.

CHAPTER VI.

General Surface of Cultivated Lands.

WE come next to consider the general surface of the cultivated lands, which is now said to amount to about four-fifths of the whole surface of the soil in England and Wales. Before we enter farther into this part of the subject, we must not, as we observed before, withhold the tribute so justly due to our countrymen, for the extraordinary improvement which Agriculture has received within the last half century, but more particularly within the last twenty-five years: indeed it affords sensations to a reflecting mind bordering on extacy, when the eye beholds extensive districts covered with luxuriant crops of grain and herbage; especially when it is observed that, within the period of recollection, many of these lands produced only a scanty herbage, barely sufficient to depasture a few stunted beasts, or miserable sheep. And when we consider, that all this has been effected by human art and industry, it would be indeed ungrateful to withhold our meed of praise; and happy indeed should we be, if there existed no cause for a diminution of the high satisfaction which, at the first view, it is calculated to afford. Highly gratified we should be, if we could congratulate every part of the community on the effects produced by these extraordinary efforts for the amelioration of the soil, the consequences of united exertion and wealth. But it is with the most deliberate concern, and with strong reluctance, that we are constrained to withhold our unqualified assent to the justness of the encomiums which have been bestowed.

Apparent and *real improvement* are often confounded, and the productions of the field, and the results from the flail, too often disappoint our sanguine expectations. Any very great increase of produce, on an average, through any country, would soon be visible, and its beneficial effects very generally felt; for, after all that can be said of *monopoly* and *combinations*, it is not in the power of man, for any great length of time, to baffle the beneficent designs of Providence in the article of food: an abundant crop, or a series of good crops, will soon bring a superfluous quantity into the market, and the prices must consequently be reduced. A better criterion of the real improvement of a country perhaps cannot be adopted. But has this, allowing for an increased population, been the case? Has not the average price of corn and shambles-meat been higher the *last* than the *preceding* fourteen years? May not what is termed improvement, prove the reverse? For we may compare the present agricultural state of this country as fast approaching to that of an overcrowded hot-house; where, from the great variety of vegetables, confined within a limited atmosphere, by the interception of the sun's rays, and the humid exhalations of a large mass of vegetable surface, *such a baneful vapour is generated,* as to disappoint the hopes of the cultivator, and greatly diminish the produce of that golden harvest, which his sanguine ideas had led him to anticipate. It has been remarked of the English Climate, that it is highly favourable to the growth of trees, but not to their fructification: the same observation is in some degree applicable to the growth of corn, particularly *wheat.*

It is my intention to shew, that vegetables of all descriptions, when growing in the shade, require, and actually possess, a larger perspiring surface exposed to the influence of the heavens, than such as vegetate in a brighter and drier atmosphere; so that an acre of land cannot support so many plants to fructification, where the prevailing weather is moist and cloudy, as under a drier state of it, and a brilliant sun. Physiologists have frequently remarked how much larger the leaves of plants and trees are when they grow in the shade; and, on investigating the reason for this increase of surface, we cannot but admire the wonderful effort made by nature to effect her purposes. The leaf, as has been already observed, is the chief elaboratory, where vegetative nature prepares the various substances discoverable in plants. The crude vernal sap, which may be considered as the vegetative chyle, is absorbed by the terminal fibres of the roots in a very aqueous state. These, experiments have proved, are propelled upwards through the capillary vessels in the outward ring of ligneous fibre, by the contractile power which these vessels possess when subjected to the stimulus of heat. This process in vegetable Economy is very apparent in the *vernal season*; if we cut off a shoot of the vine transversely early in the spring, we shall perceive an aqueous liquor to flow out through the pores, which are the mouths of vessels discoverable in the ring of outward ligneous fibre; but not through the vessels of the bark. If a quantity of cold water, at the temperature of thirty-five degrees, be then conveyed to the roots, the absorbent vessels become torpid; and the sap will cease to flow, or, as it is termed, the vine will cease to bleed; till the roots and surrounding soil have attained their previous warmth. Further, if a vine growing in a vine stove begins to display its foliage in the month of February, and the stem or trunk, which is generally outside the house, be not defended from the severity of the weather, which occurs often at this season; the foliage within the house becomes shrivelled, and the whole tree appears in a withered state: the sap being prevented from ascending by the roots, which demonstrates the necessity of heat in the process of vegetation, and how materially it is concerned in the rising of the vernal sap. This ascending of the vernal sap, of which water forms the principal part, is carried to the leaf, where, being spread over the extensive surface, it undergoes a very material change; carbonic acid air is said to be emitted in the night, and absorbed and decomposed when the sun's rays fall upon the upper surface of the leaf by day; the oxygen is given out, and the carbon retained. Water, too, there is great reason to suspect, is decomposed, its oxygen given out, and the hydrogen retained; for if hot-houses are kept very humid by the introduction of steam, or by constantly sprinkling the floor of the house with water; the leaves, in sunny weather, assume an exceedingly deep green colour: and the same effect has been observed if simple *hydrogen air* is introduced. In the artificial climate we make in our hot-houses, great and important discoveries might be made, if men of science could be induced to make experiments upon it in different states; as we have it in our power to vary the climate at pleasure, and make our observations on the effects produced by changes, in respect to dryness and cold and moisture, heat, electricity, &c. &c. &c.

It was from observing the various dimensions of the leaves of vines, when vegetating under different circumstances, with respect to dryness and moisture, and light and heat, that enabled me to prove, that a much less number of wheat plants can be brought to fructify, or arrive at maturity, on an acre of ground under a prevailing shady sky, than when it is attended with a brighter sun. The same remark extends to all other gramineous and leguminous plants, and perhaps may be extended to all vegetables, with the exception of the fungous tribes. The leaves of plants and trees, growing in the shade, are deprived of a great portion of the solar heat and light; consequently evaporation from the *under surface*, and the peculiar process of absorption and decomposition of air going forward upon the *upper surface* of the leaves, is greatly diminished. But to remedy this inconvenience, and to prevent the diseases which would otherwise be occasioned by these circumstances, Nature (ever anxious to effect her purposes) actually, in such cases, extends the scale of her organization, by increasing the diameter of the leaves; and to prevent them from shading each other, they are placed at greater distances. Thus we find, that if our cucumbers, or vines are kept very close and humid, under glass, in the way they are frequently cultivated; they become long-jointed, or, as the gardeners term it, *drawn*, and the leaves much exceed, in dimension, those which grow in the open air. I have also remarked a very distinguished difference in the diameter of the vine-leaves, when growing under *green* or *white* glass, called *crown glass*; the green glass does not permit *all* the rays of light to pass through it; white, or rather pure transparent colourless glass, on the contrary, when free from dust, transmits the *whole*. This difference is very perceptible during the time the sun shines, if the hand be applied externally to a pane of a cucumber frame, constructed of green glass; for many of the rays being reflected, we perceive a considerable sensation of warmth; but, if the frame be constructed of transparent colourless glass, this sensation is not felt: so that vines growing in a grapery constructed with green glass, even when the sun shines, may be considered as *vegetating in a certain degree of shade*.

The author of these remarks has an opportunity of exhibiting the different diameters of the leaves of the vine, under both circumstances; as he possesses a grapery, which he caused to be constructed with *white* glass, and has carefully compared the different diameters of the leaves, with those of his neighbours, constructed with the *green* or common glass.

Varieties.	White. Inches.	Green. Inches.	Open Air. Inches.
White Muscat of Alexandria	8	12	7
Malmsey Muscadine	6½	12	6
Syrian	8	14½	
White Sweet Water	6	9	6
Black Hamburgh	8½	13½	
White Frontigniac	6½	11	6
White Muscadine	6	11	6

The *wood* of the vines is equally as luxuriant under the white glass as under the green, but grows much shorter jointed, is more prolific, and the fruit of a higher flavour. The breadth of the leaf much depends on the closeness and degree of humidity kept in the house; for the more nature becomes distressed in this respect, the further she extends the means of relief, by increasing the surface of the leaves. I have seen leaves of vines, which measured *twenty inches in*

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* The first column contains the varieties of grapes; the second the diameter of the leaves growing under *white* colourless glass; the third, the same under *green* glass; and the fourth, in the open air.

diameter, growing in the lower part of a green glazed house, when the glasses of the roof were much crowded with leaves and wood, and the air kept long in a humid state.

To those unacquainted with the management of forcing houses, I must observe, that notwithstanding the advantages here pointed out in favour of *white* or crown glass, it might not be eligible in a *general way* to construct graperies with it, on account of the great skill and attention necessary for the management of them in this ever-varying climate. For as all the rays of light and heat are admitted by it into the house, if the attendant be not at hand, if he be unskilful, or if a method be not adopted for *auto-ventilation*, when the sun shines strong, the whole crop of grapes might be destroyed in an hour's time. The specks and inequalities, too often observable in white glass, are also objectionable, as they often form so many lenses that converge the rays; and if a leaf be growing in their focus, it is inevitably burnt in spots. This inconvenience, like the former, can only be prevented by speedy ventilation. The state of a wheat crop, growing under the influence of a bright atmosphere, may be compared to that of the vine in a *white glazed hot-house*; and the effect of a humid shady climate on a crop of such grain, to that produced on the vine by a green glazed house; each individual plant, in the latter case, will require more space, to enable its broad leaves and longer stalks to prepare sufficient nourishment for the formation of the ear. In this contest for light and air, the vigorous plants will outgrow their debilitated neighbours, and consequently, by depriving them of the means of extracting nutriment from the air, they are prevented from forming either large or full ears. Accordingly we find, that such plants perfect but a very small proportion of seed, and that of an inferior quality. Where heaps of manure have been placed in the field, or the dung of animals has been suffered to remain, we often find wheat plants growing excessively luxuriant, outtopping the rest of the field many inches, and appearing of a very deep green; but such plants, in our ordinary seasons, are far from producing seed in proportion to their size, or so much as those of more moderate growth; the reason of which is obvious. From their roots receiving so much ready-prepared nutriment, every seed committed to the ground is endued with a particle of life, vegetates; and the plants, becoming so vigorous as to brave the inclemencies of the winter season, are, the following summer, so much crowded, that the leaves cannot receive sufficient sun and air to perfect their seeds.

We observe a similar luxuriance where old fences have been destroyed, owing to the fertility and depth of soil occasioned by the accumulated remains of decayed vegetable matter. Farmers would do well to have their luxuriant crops thinned at the time the field is weeded in the spring; for if one-half, or two-thirds, according to the dryness or moisture of the season, were at this time removed, the remainder would produce the *best*, instead of the *worst* corn in the field. The wheat crops in this country have suffered much of late years from the humid weather experienced in July and the beginning of August. This is a very critical period with the wheat; for if we have not favourable weather during the expansion of the blossom, all the previous art and industry of the farmer will be of little avail. A continuance of wet, or cold high winds, happening at this season, causes the pollen, or fructificating powder, contained in the anthera to be blown, washed off, or rendered too dilute for effectually impregnating the embrio seeds; the consequence of which is, that the ears are not filled, or are deficient in well-formed grain. Now, as each ear contains a number of imperfect seeds, there are a portion of these too often committed to the ground, for the production of the succeeding crop; and as the imperfect ones never germinate, there is a deficiency of stock plants the following season, What a serious evil this inadvertence, or ignorance produces, we need not go far to demonstrate; the scarcity which succeeded the wet summer and bad harvest of 1799 was followed, in the autumn, by a bad seedness, or unfavourable weather for wheat sowing; rainy weather continuing till the frosts set in. A large portion of the seed, committed to the ground this season, being imperfect, the quantity of stock plants in the spring was very deficient, which was the principal cause of the scanty produce of the harvest of 1800; for the weather, during *that summer*, was highly favourable for the fructification of the wheats, had there been a sufficiency of plants on the ground.

As the various modes usually adopted to prevent the smut, blight, &c. by burning, liming, or the use of what are called *steeps*, have proved to be ineffectual for the desired purpose, that of separating corns not likely to be productive; I should recommend the following mode, used on a much less important occasion, by some malsters, for avoiding the injury arising to their *steel mills*, from the mixture of extraneous matter in barley and malt; which is, to have the corn, intended for seed, spread thin, a bushel or two at a time, on a clean floor, and all small, hard, shrivelled, hornified, worm-eaten, or *bruised grains* picked out—an employment for women and children which would be a humane and not an expensive practice.

After a favourable bloom, if the weather continues warm and dry, the ears rapidly fill, the grain becomes heavy, and the increase is abundant. But if wet weather now succeeds, and more especially if the rains are of long continuance, and attended with a calm, close atmosphere; the circulation of the juices in the plant is obstructed, in consequence of the pores being stopped by the humidity of the air, which produces a disease called the *mildew*, or *eurisiphe* of Linneus. It principally affects the *stem* of the plant, which exhibits spots of a brown colour which, in the progress of the disease, turn black. It is stated to be a *mucor* or *mold* of the fungus kind, which, when once formed, derives its nutriment from the plant it is attached to, depriving it of the saccharine and mucilaginous matter prepared by the leaves, and deposited on the stalk for the maturation of the seed. If the attack be early, and the disease attain a considerable height, the ear ceases to fill; the half-formed grains remaining in the same state as when this parasitical plant first took up its unwelcome residence: the corn is consequently shrivelled, and very light.

It has been contended by some able physiologists, that the species of fungus here alluded to is the original disease, and the *cause of blight or smut.* That this plant, which, like its congeners, can thrive with a very small portion of air and light, penetrates, by its roots, the vessels of the plant to which it adheres, and, by robbing it of its nutricious juices, may cause an effect similar to the blight, there can be little doubt; but it is probable that the disease had previously commenced in the plant, by some injury of the vessels owing to other causes; and by the stagnation of the juices, or a retrograde motion; these plants, which like putridity, may by this means find a desirable asylum. The rust (*rubigo* of Linneus) appears to differ from the *mildew* but in a very small degree; and its different appearance is perhaps owing to the fungus which adheres to the stem, being a distinct species; as the colour is somewhat different. That neither of these is the cause of what is called *blight in the ear, is evident from an examination of ears of corn, whose stems exhibit either rust or mildew.* The author of Tours through North and South Wales has informed me, that he has examined thousands of straws, taken from wheat ricks in different counties, which were nearly covered with these appearances; some even quite black, and yet the ears were as full, and the grains as perfect in those ears, as any to be found in the same ricks not the least affected. Whether this proceeded from the disease of the straw having commenced *after* the grains had obtained their full size, he had not an opportunity in these cases of ascertaining; but, in others, he has: and when this is the case, immediately cutting the grain in a *green, yet mature state*, has prevented the mischief which might have ensued from leaving it longer on the ground; because the juices of the stem being entirely exhausted, the adhering fungus would absorb the farinaceous substance of the seed. It has been observed in humid seasons to come with strong *westerly winds*; and some even go so far as to assert, that one day you shall see a field of wheat as clear in the straw as possible, and in twenty-four hours time the whole field shall exhibit visible signs of *rust or mildew*. That a check to the vegetative powers might be given in one wet cold night, is probable; and the whole fungus tribe are notorious for the *suddenness of their appearance*.

There have been few seasons lately in which the wheat in the vale countries has not suffered more or less from the disease. Small inclosures, especially if surrounded by high fences and trees, experience the evil to the greatest extent; particularly if the corn is beaten down by the rain and wind. Indeed any circumstance which has a tendency to prevent the proper circulation of air to dry the plants, and carry off their excrementitious moisture, will occasion the mildew or rust. We frequently find a difference in the disposition of the atmosphere at the time the mildew makes its appearance in some seasons; the rains in July are accompanied with calms, attended by a high barometer; at other times, the rain is from the west or north-west; the stalks of the grain, in the last instance, are dried once or twice in the course of the day, during the interval of sunshine, which greatly arrests the progress of the disease. The rains which happened last summer, 1803, in July and the beginning of August, chiefly came in storms from the *north west*; the wheat was beaten down, and that growing near lofty trees, or adjacent fences, was much injured by the mildew: but in the centre of large inclosures, and in high situations, where there was a greater ventilation, the corn received little injury.

The early part of the summer in 1803 was much disposed to humidity; upwards of three inches of rain fell in the month of June, but the weather cleared in the beginning of July, and was very favourable for the bloom. The crops appeared favourable till the 20th of that month, when a violent thunder storm happened, which completely changed the disposition of the air; several humid days succeeded, and the mildew almost universally seized the wheat in the vale districts and champaign part of the country.

Barley is a species of grain not so desirous of wet as wheat; the materials of which its farina is composed do not require the same degree of sun to prepare the juices for its formation: chemical analysis discovers no substance in this grain analogous to the vegito-animal gluten of wheat; it contains only the *amylaceous matter* united to a small portion of oil and sugar. Even the barley crops, though they require more irrigation than wheat, yet if they are sown early, so as to possess root fibres at some depth in the soil before a drought sets in, will, in a dry summer, yield a more abundant crop, and of infinitely superior quality than in a moist season*. Wheat is more impatient of cold and moisture than barley; the latter is grown as far north as latitude 60°, and even on the bosom of the north; for it has been observed that, in this respect, Finland often vies with the plains of Palestine: yet we find wheat averse to higher latitudes than 53°, and it will not thrive in an elevation greater than fifteen hundred yards. Barley is found to be peculiarly luxuriant near the sea, while wheat appears to shrink from the sea breeze; and in maritime exposure the crops are more subject to the mildew and rust than those in inland countries. It has been observed in the reports to the Board of Agriculture, that the air of Wales was too humid to be friendly to the growth of wheat; and if the moisture of our summer months continues to increase, the remark will apply to England. It has already been observed that the prospect in the field is often more flattering than in the granary; this was particularly the case the last season, 1805; nothing could look more luxuriant than our wheat fields did, in the early part of the summer; but when the ear was formed, towards the end of June, an attentive observer could immediately see that the parts of fructification were not equal to the luxuriance of the plant; the cause was not difficult to ascertain. Vegetation had proceeded for months with but a very small portion of the aid usually afforded by the sun; so that every blade of corn was extended to its utmost limit, to enable the plants to produce their fructification; and the efforts of the weaker plants were abortive, from being covered by the shade of their overpowering and oppressive neighbours. These produced ears, but none that were adequate to the expectation of the husbandman; no grains that *fill the bushel*, as the adage is, were to be discovered; their contents at best, being only a light shrivelled substance, scarcely deserving the name of wheat. I wish here to be considered as speaking of the *county of Worcester only*, where I had an opportunity, from its being my usual residence, of making the most accurate observations and enquiries. How far other counties may have experienced more favourable weather, and better crops at the same period, I have not at present the means of ascertaining, at least not with that precision I could wish, and therefore I shall not presume, without more decisive evidence, to give my opinion; but of this I am well assured, and my own observation has enabled me to ascertain, that the crops in Worcestershire fell much short of an *average produce*, owing to local failures from the mildew, rust, and other accidental causes. Malmsbury says, the yield of corn in the *eleventh century*, in the vale of Glocester, was a hundred fold; and though I agree with his commentator, Camden, that the learned monk may have drawn rather too flattering a picture, yet if my theory be founded on fact, *that our Island, at the time he wrote, had a less exhaling surface, than at the present time, the additional genial heat and light of the sun, with a less clouded and humid*

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* A long experienced and observant agriculturist informed me, in answer to queries I sent to him on this subject, that, in the course of forty years experience, he grew more barley per acre in peculiar *dry*, than in *wet* summers, during the course of that period.

atmosphere, would enable the arable lands to support a much greater number of wheat plants per acre, and perfect their seeds, than can be effected under the usual state of our present atmosphere; at the critical periods of bloom and maturation.

The Island of Sicily, in the Mediterranean, was famed for its great fertility in grain, even as early as the time of Homer; and a modern traveller, Mr. Brydone, who visited this celebrated Island in the year 1770; remarking the present state of the country between *Agrigentum* and *Palermo*, says "The fertility of many of the plains is truly astonishing, without inclosures, without manure, and almost without culture; it is with reason that this Island was styled "*Romani imperii hordeum*," the Granary of the Roman empire; and perhaps were it properly cultivated, it might yet be an auxiliary granary for Europe. Pliny says it yielded a hundred for one; and Diodorus, who was a native of the Island, and wrote on the spot, assures us, that it produced wheat and other grain spontaneously; and Homer advances the same fact in the Odyssey:

> "The soil, untill'd, a ready harvest yields;
> With wheat and barley wave the golden fields;
> Spontaneous vines from weighty clusters pour,
> And Jove descends in each prolific show'r." Pope.

Pliny remarks, that the grain in Sicily yielded a hundred for one, it was probably like the observation of Malmsbury in the vale of Glocester, the result of previous enquiries; for no modern writer would dare to assert, from a casual view of our present wheat crops, that the soil of England yielded *a hundred fold;* when every ploughman he met could tell him that the produce of a fair average crop of wheat, at the present time, does not exceed *thirteen fold* on the usual plan of broad cast husbandry: but we find, where the *drill husbandry* is practised, there is a difference as to the quantity of seed used, which is from one bushel to one bushel and a half, and where sown *broad-cast*, it is two to three bushels. Now if we take the average of seed grain *at two bushels per acre*, through the kingdom, the statement will probably be accurate; for the produce of an average crop of wheat may be about twenty-five bushels per acre. I grant there are lands so naturally fertile, or so fertilized by art, that, in favourable seasons, they will yield from *thirty* to *forty* bushels per acre; and old turf lands, when recently converted into tillage, have been known to yield, the first year, with favourable weather, forty-five to fifty bushels per acre; but when these few extraordinary crops are blended with the products of many extensive districts, which do not yield more than fifteen to twenty bushels per acre, it considerably lowers the average: and I am inclined to think, *my ratio of twenty-five* *bushels per acre* to be near the truth[*], which makes the increase on the seed sown *only twelve and a half, for one.*

Barley yields a larger produce per acre than wheat, as has been before remarked. It does not require the same degree of heat; the leaves are narrower, and stems shorter; so that a greater number of plants can be supported on a given quantity of land. The average produce of this species of grain may be considered from *thirty to forty bushels per acre*; but there have been instances of light highly-manured lands producing *sixty*, and even seventy bushels per acre: a single grain of wheat, cultivated in a garden, with every assistance that art could give it, has been known to produce a thousand grains. We find our fields to yield a return of scarcely *thirteen for one.* I mention this circumstance to shew what an inconceivable quantity of the seed committed to the ground, must either perish, be destroyed by insects, devoured by birds and other vermin, or not fructify to advantage, owing to unfavourable weather. A great number of plants probably perish in this northern climate, during winter, from the sudden changes and severity of the weather. To guard against these casualties, it is necessary to have a superfluity of stock plants in the first instance, as a reserve for such irremediable accidents. Many attempts have been made of late years to reduce the quantity of seed-wheat; but I do not yet learn, that it has been attended with the wished-for success. The *drill-husbandry*, which has become the fashionable practice, certainly saves the nation annually a considerable quantity of grain in addition to its other advantages over the system of *broad-cast*; but in poor lands it is absolutely necessary to sow abundantly, as more plants will on such lands be cut off in the winter: nor do the plants branch out, *stole*, or *tillor*, as it is called, in the way they are found to do in more generous soils. The effect of manures in enabling plants to support a vigorous vegetation in unfavourable weather, is agreeably seen, when cold rain, snow, or hail storms happen, towards the latter end of the month of April; the young barley plants then turn yellow, and many perish, while those growing in parts of the very same field, where manure has been more liberally bestowed, retain their verdure, and brave the inclemency of the weather. When the barley is sown early, which was the case the last season, 1805, and snow or hail-storms occur, accompanied by frosty nights, or cold winds, the plants turn yellow and look sickly ; the roots, as well as the upper part of the plant, suffer from the torpor produced by the cold; for I found that a tube filled with water, and buried *at nine inches below the soil,* was cooled down to thirty-eight degrees of Fahrenheit's thermometer on the 30th of April; some snow had fallen the two preceding nights; the barley plants looked very yellow, and did not recover their green hue till some time afterwards: when rain came from the south-west, and the thermometer rose to *fifty-four degrees.* In light gravelly soils, the plants recovered, and assumed a healthy complexion in forty-eight hours ; but in the cold clays they continued to look sickly much longer, and, *in some situations,* never were healthy any more. This has been often observed by attentive farmers, who have endeavoured, without success, to account for the difference. It has occurred to me, that the reason why barley plants are so soon restored to a state of health, during warm rains proceeding from the south, in gravelly soils, and not in clays, may be owing to this cause. In the former case, the soil, being loose and pervious to water, sooner admits the warm rain water to descend to the roots; and, by the combined humidity and warmth, the vegetative principle is quickly brought again into action. As a proof of this suggested idea, the tube, containing water buried in the same soil, being examined when the barley field had recovered from the check it received by the cold on the 7th of May; was found to be forty-nine degrees, being eleven degrees higher than it was on the 30th of April. These warm rains cannot so soon produce their effects on the roots of barley radicating in clays, not only from the natural impenetrability of the soil; but from the preceding cold winds hardening the surface: so that when the rains, accompanied by warmer winds, came, while the upper part of the plants were enjoying a genial temperature, the roots were still paralysed with damp and cold.

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[*] A gentleman who has possessed means of obtaining accurate information on this subject, in various parts of the kingdom, and who has been assiduous in his agricultural pursuits, more especially in this important branch; assures me, that the average annual produce of wheat through the kingdom, is not more than *twenty bushels per acre.* That I might give a fair estimate on the question, I have exceeded the assigned quantity, and placed it high at *twenty-five.*

We cannot expect, in this variable climate and northern latitude, to produce such large returns of grain from the seed sown, as in the more favoured Island of Sicily; it is true, art may powerfully assist nature, and in England it produces surprising effects in agriculture; but still our principal reliance must be on the benign influences of the heavens: for, without due irrigation, and a proportion of light and heat, our greatest efforts will be of little avail. If we possessed accurate registers of the weather in countries celebrated for their fertility, more especially in such whose vegetable produce is similar to our own, it would doubtless render our knowledge in agriculture still more extensive; particularly if, in addition to the state of the weather, we were made acquainted with the minutiæ of their rural œconomy. According to Mr. Brydone's journal, during his residence in Sicily, in 1770, it does not appear that the thermometer stood higher, during the day, than it does under a bright atmosphere in the summer months in England. He found the range in the shade, from the 17th of June to the 10th of July, was from seventy-two to eighty degrees, by Fahrenheit's thermometer, in the interval of this period; but he informs us the sky was only obscured *twice*, the 26th of June, when there was a smart shower of rain, which continued for two hours, and again upon the 8th of July, when a *Sirocco* wind blew, attended with haze; the thermometer then rose to the extraordinary height of one hundred and twelve degrees, and continued at that pitch for many hours. I shall have occasion to take further notice of this extraordinary phenomenon, when I come to point out the probable effects of a dry, or moist atmosphere on the animal œconomy.

CHAPTER VII.

On the Increase of Pasturage beyond that of Tillage.

AMONG other causes which powerfully contribute towards forming our clouded atmosphere, is the *late increase of pasturage beyond the proportion of tillage.* A variety of circumstances have concurred to produce this alarming increase of pasturage; amongst others, and in the foremost rank, stands Luxury, the consequent attendant on a flourishing commerce; this I conceive to be one of the principal causes; for if, in addition to the horses required for the purposes of agriculture and trade, we add those kept solely to administer to our pleasures, we make an aggregate so enormous as not to be paralleled by any other country of equal extent on the face of the Globe. Seventy years since such a carriage as a post chaise was not to be met with, and few of our cities could support more than one weekly diligence for the conveyance of passengers between them and the Metropolis. The provender necessary to support such an increased number of horses in the way they are generally fed, consequently requires a very large proportion of lands to be appropriated for the growth of grass and hay. To this we may add the increasing demand for animal food, butter, cheese, cream, &c, from our luxurious manner of living, and the gradual disuse of religious fasts*.

The surface necessary to support so large a number of graminivorous animals must proportionably infringe on the extent of tillage; and in the neighbourhood of large towns we are consequently now obliged to extend our walk to a much greater distance than our ancestors did, if we wish to feast our eyes with the sight of corn fields. From the first dawning of spring, when the grass starts, till the autumnal frosts prevail, our highly-manured pastures are constantly exhaling a large portion of vapour; and this vapour, agreeably to the experiment of passing steam through the interstices of the leaves of vegetables, is much deprived of its electricity; consequently the sun has less power in dissolving it into transparent air. This conducting power of grass is agreeably seen in a calm evening after a warm day, as we have observed, before any general precipitation of nocturnal dew commences; we then see the points and edges of the grass beautifully tipped with small globules of water, resembling orient pearls. The soil and vegetable surface having been heated by the solar rays in the day, as soon as the atmosphere becomes cooler from a declining sun, the rising vapour is condensed, and we see it frequently in the form of a white cloud, about a foot high, on the surface of our meadows. The intensity of the Electricity is increased by the condensation as before explained; and all the humid particles, floating near the blades of grass, are attracted, and increase in size till they become visible to the eye, by assuming the well-known form of drops of dew.

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* The Lent and weekly fasts, on Wednesdays and Fridays, prescribed by the ritual of our church, appears to have been regularly attended to for the first century after the reformation.

The effects of tillage, when compared with pasturage, in rendering the atmosphere of a country less humid are, that the vegetable produce on arable lands exists, and consequently its exhaling power, *only during a part of the year*, and the quantity, therefore, is much smaller; accordingly we find our autumns in general dry and pleasant, and not so disposed to cloudiness and showers as during the time of Spring and Summer. When the grain turns colour, and arrives at maturity, an important change commonly takes place in our Atmosphere. An immense exhaling surface suddenly ceases to afford its abundant moisture to the air, and at harvest, when the grain is removed, the conducting surface also is materially diminished; the outward crust of the soil, now receiving the rays of the sun without interruption, soon becomes dry, and, in this arid state, sends up rarified air into the Atmosphere, which contributes to preserve the insulation and consequent transparency of the floating vapour. We have not experienced a wet harvest, or autumn, since the year 1799; and when this unfavourable circumstance does occur, it certainly proceeds from some general cause with which at present we are totally unacquainted. This disposition of the air will, I am persuaded, prove not to be *local*, or merely confined to the British Isles; for, on enquiry, we shall find our continental neighbours partaking of the calamity, equally with ourselves*.

One practical branch of our rural œconomy consists in occasionally exposing our arable lands to the influence of the sun and air by a process which we term *fallowing the ground*; and the aeration and pulverization the soil thus undergoes, powerfully contribute towards the destruction of noxious weeds and voracious insects, and thus increase its future fertility. When the outward crust of the soil becomes dry, the arid air which we observe undulating on the surface of the ground, in a sunny day, effects nearly as much towards dividing the humid particles, and rendering a vapourous atmosphere transparent, as the sandy deserts in Africa or Arabia. In this view of the subject, it is lamentable to find, that in some extensive districts, the system of fallowing is in a great measure superseded; for if this new system should become universal, it will, in the end, produce a national calamity: since it is highly probable this reduction of fallows may have contributed in addition to the causes already enumerated, towards producing the cold humid summers of which we complain. If the exposure of a portion of the soil to the solar influence during summer, in an uncropped state, tends to produce settled serene weather, which I shall prove it certainly does, we do not, by such practice, experience any loss as to quantity of produce, because the lands under crops amply make up the deficiency by their more abundant products. No country on the face of the globe perhaps supports so great a population on a given extent of surface as China; the climate is represented, by Sir George Staunton and others, as highly favourable to the growth of corn and fruits; the prevailing weather in summer being uniformly settled, with a transparent sky. Artificial Irrigation, therefore, is much used in the vicinity of their rivers, particularly for the rice grounds; but to suppose that such Irrigation could be extended over the whole face of the country is supposing an impossibility. The natural fertility of the soil is much increased in that country by the great attention paid to the preservation of manures. The Chinese indeed carry their œconomy, respecting this article, so far, that we are informed earthen vessels are sunk in the ground by the sides of public roads, and in other convenient places, for the accommodation of travellers. By this plan, excrementitious materials are here preserved, and profitably applied to the purposes of agriculture. It appears that most of the seed grain is previously soaked in a solution of this powerful manure, before it is committed by the sower to the ground*. The great inconvenience so often arising to barley crops from the seed germinating irregularly, or having, as it is termed, come up *at twice*, and consequently ripening at different periods, would be thus effectually prevented; and as so much depends on the early stage of animal and vegetable life, the additional nutriment given to the embryo plant, at its first entrance into life, would probably be attended with a continually-increasing vigour throughout every period of its existence. If the experiments reported to the Bath Agricultural Society in 1783, be accurate, the advantages attending this practice have been ascertained to be very great indeed.

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* Our soldiers can bear witness to this fact, who were in the unfortunate campaign in Holland; the misfortunes attending which, were perhaps in some measure aggravated by this circumstance.

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* Probably were our farmers to soak their seed barley for twelve or twenty-four hours in the fine black carbonic liquor which exudes from dunghills and stables, it would be attended with considerable advantage, especially on impoverished lands, situated at a distance from towns, where there is always a difficulty of procuring adventitious manure.

A late writer, Mr. Barrow, speaking of the fertile province of Pe-tchr-lee, says, "This uniform plain of China afforded little interest to the traveller; few trees appeared, except now and then a clump of firs surrounding a temple, or plantations contiguous to the dwelling of some officer of government; in such situations were also large elms, willows, and a species of ash unknown in Europe. There were *no hedge-rows*; property here is divided only by narrow *ditcehs*, serving at the same time for *drains*, or by ridges of unploughed land, as in the common fields in England, which answer the purpose of footpaths. Horses are rarely kept for luxury, or for labour, and the few animals employed in agriculture, which are mostly asses, mules, or buffaloes, subsist in the winter season on chaff and straw; and their chief support in the summer is derived from the strong grasses that grow in the ditches, and the common reed with which, in this part of the country, large tracts of swampy ground are covered."

There cannot be a stronger proof of their œconomy in cultivating the ground, than the statement given by Chon-ta-Zhin, by which it appears that Pe-tch-lee supports a population of thirty-eight millions, on a surface of thirty-seven millions seven hundred and twenty-seven thousand three hundred and sixty acres!!! The population is therefore more than double, yes, nearly treble to that of England, Scotland, and Ireland united, although the surface of land is much less. It is not intended by this statement to form a rigid comparison with the British Isles, as such a comparison would be unfair, when we consider the scanty portion of sun we enjoy in this northern latitude, and that our considerable tracts of hilly ground cannot be expected to yield such a produce as the level and fertile plains of Pe-tch-lee.

Egypt has also been celebrated, for its great fertility in grain, from the earliest ages; a most interesting history, contained in the sacred writings, first introduces this country to our notice in this desirable point of view.—(*Genesis* 41, *v.* 34.) The produce, in favourable seasons, appears to have been immense; Moses informs us that the surplus, a fifth of the annual crop preserved in store for seven plenteous years, was sufficient to support the population of the country during seven successive years of famine, and at the same time to allow of exportation, so as to afford considerable relief to the neighbouring nations, subjected to a similar scarcity: and, in the seven plenteous years, the earth brought forth by handfuls; and Joseph gathered corn as the sand of the Sea, very much until he left numbering.—(*Genesis* 41. *v*. 47. 49.) This great degree of fertility appears not to have deserted this country, even to the present time; for it is apparent, from the best accounts, if the soil were properly cultivated, no land of equal extent, in any part of the world, would yield a greater return. In Egypt there is no obstruction to vegetation, arising from want of sun, as clouds are seldom seen, except occasionally on the coast in the division of the Delta. The Irrigation of the soil in Egypt is effected by the annual overflowing of the Nile, occasioned by the tropical rains at its source, in the mountains of Abyssinia. The country being very level, great part of the land is inundated by the overflowings of the river; when the vast flood arrives at its greatest height, sluices are opened, which communicate with canals made for the purpose of becoming reservoirs for artificial irrigation. When the waters of the Nile return into its natural bed, an oozy slime of a highly fertilizing nature is found deposited on the surface of the ground; the seed is then committed to this productive soil, and yields the abundant crops, the account of which seems to stagger belief. Although it scarcely ever rains in Egypt, the dews, during the night, are very considerable, and what farther moisture is requisite for the process of vegetation, is supplied by the canals. When we consider the face of the country, it will appear by no means extraordinary, that, in the interior part, it very seldom rains; being an uniform flat, no mountains exist to attract the vapour, and deprive it of its Electricity: and the surrounding country, except the vale of the Nile, is a dry sandy desert. The nocturnal dews are caused by the humid air brought in by the northerly wind during the day, and from the vapour raised by the sun from the Nile, and from the growing vegetable produce; which is in part precipitated in the night, and without doubt is of essential service in preserving a vigorous vegetation.

In Sir Robert Wilson's account of the late British expedition to Egypt, he notices the present state of agriculture; a quotation from which may be useful, as it shews *the quantity of grain produced under a climate, where the sun's rays are* *not intercepted by a vapourous atmosphere.* "At present the ground annually yields three crops; with care it might be made still more productive: even now, after affording subsistence to a population of three millions, vast supplies are sent to Arabia and Turkey. Barley, wheat, and rice, grow almost spontaneously; the seed of the former is generally only scattered on the earth, or rather mud, and ripens in four months. Flax, trefoil, the plant from which indigo is extracted, the carthamus, the cotton tree, flourish throughout Egypt; the sugar cane grows luxuriously, and excellent sugar is manufactured; the olive tree is to be found, and the coffee tree, with attention, might certainly be introduced: in short, every thing which the wants and luxuries of Europe demand, might here be cultivated." The best informed persons believe, that even now Egypt could annually export above a million of quarters; on an average a crop of corn in Egypt yields from twenty-five to thirty measures for one; in extraordinary years the land gives a produce *of fifty for one*; and instances have occurred where one hundred and fifty times the seed sown has been reaped. The Egyptians prefer sowing barley to oats, as they find their horses to live as well on it, and the land is not so much exhausted by that grain." In a philanthropic and philosophic point of view, we cannot but seriously regret, that this fertile province was again given to the wretched government of the indolent Turks and oppressive Beys. It would indeed have been a glorious act, to have rescued a degraded population of three millions of people from the tyranny of such miserable governors, and to have introduced a system of morality and virtue, founded on the basis of the Christian religion; the benefit Europe would have derived, in participating the produce of this fertile country at the present time, when an extended population has lessened the resources of subsistence, might have been incalculable.

The West India Islands present to us the effects of a variation in climate from *local causes*, where other circumstances are nearly similar. From the remarks on the meteorology of these Islands, by Mr. Bryan Edwards, we have an opportunity of observing the influence of a mountainous country and vegetable surface in rendering the Atmosphere humid or dry; "Spring," he observes, "may be said to commence in the month of May; the foliage then becomes more vivid, and the parched savannas change their russet hue, previous to the first periodical rains, which generally set in the middle of the month; these, compared with the autumnal rains, may be said to be gentle showers; they come from the south, and commonly fall every day about noon, and break up with thunder storms, creating a luxuriant vegetation. The thermometer, at this season, varies considerably, commonly falling six or eight degrees immediately after the diurnal rains; its medium height may be stated at 75°; after this weather has continued about a fortnight, it is dry, settled, and salutary; the tropical summer reigns in full glory; not a cloud is to be perceived, and the sky blazes with irresistible fierceness; for some hours, commonly between seven and ten in the morning, before the setting in of the sea-breeze or trade wind, which, at this season, blows from the south-east with great force and regularity until late in the evening, the heat is scarcely supportable; but no sooner is the influence of this refreshing wind felt, than all nature revives, and the climate in the shade becomes not only very tolerable, but pleasant. The thermometer varies but little in the whole twenty-four hours; its medium, near the coast, is about eighty; I have seldom observed it higher than eighty-five at noon, nor much below seventy-five at sun-rise. The nights, at this season, are very calm and beautiful. This weather commonly continues from the beginning of June to the middle of August; when the day breeze begins to intermit, and the atmosphere becomes close and sultry. In the latter end of the month, and beginning of September, we look in vain for shelter and coolness; the thermometer occasionally exceeds ninety, and in place of a steady and refreshing wind from the Sea, there are faint breezes and calms alternately: these are preludes to the second periodical or Autumnal rains. Large towering fleecy clouds, of a reddish hue, are now seen in the morning in the south and south-east; the tops of the mountains, at the same time, are devoid of clouds, and the objects upon them appear of a bluish cast, and seem much nearer to the spectator. When this vapour has risen to a great height, it commonly moves horizontally towards the mountains, with deep and rolling thunder. The waters do not fall with great force till the beginning of October—it is then that they come down in such torrents as an inhabitant of the temperate climes has no conception of. *The perpendicular height of water falling at Barbadoes, in one year, measures sixty-seven inches;* in the interval between August and October is the season for expecting hurricanes. Towards the end of November, and the beginning of December, a change takes place in the temperature. The coasts to the north are now beaten by a heavy sea; the wind varies from east, to north east, and north; the north wind then prevails, and the atmosphere is cleared; serene weather now succeeds, with north-eastern, and northerly winds; and from December to the end of April, it is very pleasant, and may be called Winter. This is a general representation of the meteorological phenomena of these Islands; but in the larger Islands of Hispaniola, Cuba, and Jamaica, whose lofty mountains are covered with forest wood, perhaps as old as the deluge; the rains are more frequent and more violent than in the smaller Islands to windward: some of which are without mountains, and without wood. In the elevated districts of the three former Islands, there are showers in every month in the year; and on the northern coasts of these Islands considerable rains happen in December and January, on the setting in of the north wind. The larger Islands, in the night, have land winds, from their irregularity of surface; hence a wind is felt in all mountainous countries under the torrid zone; and where there is a ridge the night air descends on both sides. In the Islands to windward they have no land breeze; for in Barbadoes, and the other small Islands, the sea breeze continues all night."

I have introduced this long quotation to shew *how much the variation of weather depends upon local causes.* The Leeward Islands, as they are improperly called, are some of them in the same latitude as Jamaica and St. Domingo; among the former, some being low and flat, and possessing little wood, are liable to great droughts, during the intervals between the vernal and autumnal rains, owing to a want of conducting and exhaling surface, to deprive the atmosphere of its electricity, and thus to dispose it to form clouds and storms. The regular winds which these tropical Islands experience, are very satisfactorily accounted for on obvious principles, being explained by the annual and diurnal motion of the Earth; thus, for instance, when the Earth's annual motion occasions the solar rays to fall vertically within the tropic of Cancer in June, the land being heated on the American main, in the vicinity of the Floridas, will occasion a south east wind, both in the Windward and Leeward islands; but towards the middle of August and beginning of September, when the solar rays have acquired some force in the tropic of Capricorn, the heat on the north and south American main, in the vicinity of these Islands, is nearly equal; the diurnal wind from the south-east then intermits, with faint breezes and calms alternately. Vapour, at different temperatures, and in different electrified states, becomes thus intermixed, producing a clouded Atmosphere; till at last the air again deposits the enormous quantity of vapour, which it had previously been absorbing from the Earth and Sea, and which is again precipitated in the immense torrents described by those who have visited tropical climes. Towards December, the South American main, being most heated, will occasion a north-east wind in most of the Islands; the point of the compass from whence this wind blows, must vary according to the longitude of each Island; thus, in Barbadoes, in the month of January, on this hypothesis, it would be north-east; in St. Domingo and Jamaica, north; and at the Havannah and western coast of Cuba, north-west.

The American climate presents us with some peculiarities, an attention to which may possibly extend our meteorological knowledge. Mr. Kirwan found the annual mean temperature of North America to fall short of the European standard ten degrees, and in some situations still more. The same causes are at present producing the same effects on the American continent which they originally did in the northern parts of Europe. When the Europeans first began to emigrate to North-America, about two centuries since, they must have found the climate very similar to what Britain, Gaul, and Germany experienced twenty centuries ago—that is, by being over-run with wood, a vapourous atmosphere was generated in summer, causing frequent rains, and preventing the solar rays from falling on the Earth; to this may be added the quantity of heat carried off by evaporation, which, leaving the Earth cooler in Autumn, occasions the winter frosts to set in early, and seldom fails to add to their intensity. The Americans have already begun to experience an amelioration of climate by the introduction of the arts connected with Agriculture; such as the clearing of woods, draining of morasses, &c.; and as the population increases, the climate will long continue to improve; so that, in a few centuries more, their rivers, situated in the same parallels of latitude as those in Europe, will probably not be frozen so early in the winter as they at present are. The climate of America is subject now to very great variations of temperature, and to great humidity; the north-west wind is complained of as accompanied by excessive cold, occasioned by its passage over a vast extent of elevated and wooded ground; and the humid south-west wind, which blows from the gulph of Mexico is in the contrary extreme, bringing with it excessive heat. The health of the inhabitants is said to suffer very severely from these great and sudden changes of temperature in the Atmosphere. The gradual effect of clearing the vast tract of country, which extends to the north-west, cannot be accomplished even by an increasing population for many centuries to come; but if the American government were to persevere in a system of thinning these vast forests, by debarking, or otherwise injuring the trunks of the largest, and least valuable timber trees; even though they were not completely removed, they would, in all probability, considerably tend to improve the climate in a much less period, than that assigned.

As it is not yet deemed improbable but a north-west passage may be discovered at some future time, when the climate of the northern extremity of the American Continent is less severe, it might be policy in the British government to adopt some measures for lessening the quantity of woods on the Island of Newfoundland, and the back settlements of Canada; for if the frozen seas in the unexplored part of the world to the north of these countries, were only rendered navigable during the summer months, it would much facilitate our commerce with the empire of China, and the Isles situated in the Pacific ocean.

When we contemplate the great changes the vegetable surface of the ground has undergone in England, within the last thirty years only, it is not surprising we should find a difference of temperature at the same seasons; especially in the Spring, and before harvest, when the exhaling and conducting vegetable surface has its greatest influence on the climate. It has already been remarked, that observers of the weather date the commencement of this unfavourable change in the Spring and Summer from the year 1775, which is about thirty years ago, and corresponds with the number of *inclosure acts* which have taken place since that period. All land which has been rescued from a state of nature, and subjected to the operation of the plough, within the period of time now under consideration, presents a larger vegetable surface to the influence of the Sun and Air in Spring and Summer than when in a state of waste; except such lands as were previously mere bogs or morasses: these undoubtedly exhale less; but the quantity of inclosed land of the latter description bears but a small proportion to the general mass. It may be necessary to remind my readers of what this vegetable surface, lately inclosed, consisted, when in a state of nature. The indigenous vegetables, usually found growing on our commons, vary much according to soil and situation; but they may be generally comprehended under the denomination of gorse, heath, fern, moss, and a few natural grasses. The exhaling power of the first two has been proved by experiment to be very little; the fern does not fully expand its new leaves till the end of

May, nor the gorse and heath till as late as June; with respect to the natural exhaling surface of the grasses found on our wastes, I need not compare it to that of our inclosed and manured pastures; for these lands, by the assistance of agriculture, produce a much more luxuriant herbage. The very process of ploughing only, would improve the depth of soil, and increase its power to support vegetation; but when the usual aids of lime, marle, coal ashes, the excrement of animals, and other remains of decayed organization, are had recourse to in addition, the fertility of the land is greatly increased, and, when cropped with gramineous vegetables in the place of those already enumerated, such as wheat, barley, oats, rye, flax, &c.; the leguminous, as beans, peas, vetches, clover, and trefoil; tetradynameous, as turnips, rape, cabbages, &c. &c.; with the fields intersected, at the extent of every ten or fifteen acres, principally with *hawthorn fences*, in the hedge-rows of which we frequently meet with elm, ash, poplar, apple, and other fruit trees, together with the appendage of weeds, the land exhales moisture beyond all proportion greater than what it did in a state of Nature. Now from the experiments of Dr. Hales and others, noticed by Mr. Kirwan, in his enquiries into the temperature and Meteorology of different latitudes, it appears, that tracts of land covered with trees or vegetables, emit more vapour than the same space covered with water to the *amount of one-third*—(*Phil. Trans. vol.* 2*d, p.* 150.) And as clear transparent air does not obstruct the rays of heat and light, and opaque vapour does, we are deprived, in a great measure, of the solar influence, as soon as this vegetable surface is in action; so that from about the middle of April to the end of June, the air is constantly in an unsettled state; for if the sun breaks out for an hour or two, in the middle of the day, it feels very warm; but not continuing to shine out a sufficient length of time to warm the earth, if a frost happen during the night, which is frequently the case after such kind of day, the cold not being moderated by acquired heat of the ground, becomes so great as to produce a diseased circulation in the leaves of vegetables, and is consequently followed by *blights*, &c. which subject them to become the prey of insects. Since the idea occurred to me respecting the influence of our increased vegetable surface, in producing the cold we usually experience in the Spring and early part of the Summer, I have particularly noticed the weather immediately after the Vernal equinox; when the sun is every day shining with less obliquity in our Hemisphere. Between the 20th of March and the middle of calm frosty night, a thermometer, placed near the ground, will be colder than one at a greater distance; and by placing others at the respective heights of twenty, thirty, fifty, &c. to two hundred feet, that the temperature rises in proportion to the *distance of elevation*. Hence we discover the reason why, during frosts in April and May, gardens, fruit-trees, &c. situate in low situations, suffer the greatest injuries. This effect is very perceptible in the ash; the foliage of the lower part of the tree being often wholly cut off, while the upper branches frequently escape; and the same tree, situated on high ground, is not in the least injured.—*(See Phytologia, p.* 305.*)* This freezing stratum of air or lower term of congelation, in latitude 52°, in the month of April, exists at the height of fifty-four hundred feet; and in May at upwards of seven thousand feet: and, as vegetables suffer most when the air is moist, we see the necessity of preserving our tender fruit trees as much as possible from a vapourous atmosphere at this season. The highly-manured pastures, in the neighbourhood of large towns, begin to shew a green verdure much earlier in the season, than lands situated at a considerable distance from such towns; this early grass is not produced by greater warmth, but from the effect of manures, which act both as a stimulant and a pabulum, by conveying ready-prepared nutriment to the roots; so that it is brought preternaturally forward, and acquires a power to exhale moisture long before lands less forced by manure, and much earlier in the season than the natural grasses upon uninclosed wastes: so that if we have not warm southerly winds, or dry transparent days, by which the earth may be warmed, and thus enabled to resist the descending stratum at night, we are deprived of our early esculent vegetables and beverage fruits. Indeed the produce of our orchards has become so precarious for the last *twelve* or *fifteen* years in the counties of Worcester and Hereford, from the casualties of the weather, experienced during this period in April and May, that the best informed persons begin to doubt whether or not, under the present circumstances, the trees may not be considered as an incumbrance to the lands, and orchards be no longer worthy of cultivation.

The north-east winds, which happen at this season, are not so much disposed to form storms of hail and rain as the north-west, but they frequently bring snow if the wind is brisk; and if such wind is only moderate, it is always attended with a *blue mist and vapourous atmosphere*, very unfavourable to the circulation of the sap in the recently-expanded foliage: and never fails to produce that plague of fruit-trees, the *Honey dew*, and numerous other diseases usually denominated *blight*. One species of blight, which is generally said to be produced by lightning, and commonly happens towards the end of April or beginning of May, I have particularly attended to, and am well convinced it does not proceed from the cause thus generally assigned; it is *that appearance* which our cherry and apple trees frequently present to the eye at this season, when the leaves seem as if actually burnt with fire. This never happens but in *calm* mornings, which succeed frosty or very cold nights; Miller calls it a "*fire-blast*;" but modern gardeners attribute the effect to lightning; it is, however, caused, as I have repeatedly proved, from experiment, by the solar rays falling on the leaves, when there is no wind to carry off the perspiring moisture; consequently the temperature of the leaf is raised so high as to destroy the vital principle by excess of stimulus. The appearance, in the course of an hour or two after it has happened, is as if the leaves were scalded, but, in a day or two, becoming dry, they assume a brown colour, and *look as if they were burnt*. Trees, fully exposed to the morning sun, and in close, crouded situations, are most subject to this calamity; the excitability of the vital principle being accumulated by the cold of the night, is thrown into strong action, from the influence of the solar rays in a bright morning; and if the air is perfectly calm, an atmosphere, which is soon completely saturated with moisture, surrounds each leaf; its temperature is raised, like a green board, or any other substance capable of absorbing heat, and thus destroyed by excess of stimulus. In May 1805, several standard cherries and apples were thus injured in my gardens. The morning when this accident happened was perfectly bright; a dead calm prevailed till near eleven o'clock: when, observing that the trees were blighted, I examined them, and remarked, that many of the branches on the *north west side* of the trees, were not injured. Two morella cherries grew against some old paling, part of the trees being trained on the *eastern*, and some of the branches on the *western* side of the pales: these trees were only blighted on *one side* of the paling—that was, on the *east*. Now, if the injury had been caused by Lightning, it is probable both sides of the tree would have been equally injured. But what corroborates the opinion that this kind of blight, as it is called, is owing to the temperature of the leaf being raised higher than nature can bear, is, that I have observed, if the sun breaks out strong upon a hot-house, in which the inclosed air is kept very humid in a calm spring morning; the leaves of these vines which receive the solar rays become injured; if proper air is not immediately admitted, the leaves look as if they were scalded; in a day or two they dry up, and then appear as if they were burnt. Whenever this accident occurs, if the hygrometer is noticed, the air of the house will be found *exceedingly humid*, almost to saturation, which prevents the perspiring process from going on; and, when this is stopped, the leaf is liable to be heated in the same degree and manner as any inorganic matter; hence, in the month of May, or beginning of June, if there has been a continuance of drought, and there happen to be a slight rain, should the Sun break out the following day, the practical farmer complains, *that his wheat and barley burns worse for the rain*; which is really the case; for the lower leaves are then growing in an atmosphere nearly saturated with moisture, so that the air cannot absorb the vapour given out by the grain: and if the weather be calm, and the corn be growing within small inclosures, where there is little ventilation, the lower leaves are actually *burned*, on account of the evaporating process being thus prevented from going on upon the surface of the leaves.

The evaporation from the leaves of vegetables produces the same effect in keeping down their temperature, when the Sun shines on them, as the perspiring surface of animals. It is well known that the heat of the human body, when in health, does not exceed ninety-eight degrees; but the wise and beneficent Creator has so admirably constructed our organization, that we are able to exist, when the atmosphere exceeds this standard; as it often does on sandy deserts, in tropical climates, where the thermometer frequently rises to one hundred and ten in the shade; but the perspiration then becomes so copious, that the excess of heat is carried off by this means, and men have actually exposed themselves to an atmosphere raised as high as one hundred and forty degrees; and yet a thermometer, placed under the tongue, or in the axilla of the arm, has not stood higher than about half a degree above the standard of health.—*(See Dr. Fordyce's Experiments.)* In this case all the superfluous heat is carried off by evaporation. Hence we find that Hollies, Laurels, Phillareas, Magnolias, and most evergreens, which perspire less than deciduous trees, have a peculiar organization to remedy the inconvenience which they would suffer from excessive heat; for their upper surfaces are so finely polished, that they reflect a portion of the sun's rays into the atmosphere. On the other hand, such vegetables as require to part with a large portion of water to enable them to prepare their proper fluids, have this perspiring surface increased by a hairy down on the upper and under side of the leaf; this multiplication of exhaling surface on some plants is very great: and leaves so constructed probably perspire from the *upper* as well as *under* side. This induced me to form an opinion, that the leaf of the Elm perspired more than that of the Oak, before I had tried any comparative experiment; from observing that the Elm leaf possessed an hairy upper and under surface, and the Oak a smooth one. We find, in our inhabitants of the green-house, too, that the balm of Gilead, hairy-leaved Geraniums, &c. require a much larger portion of water than the Myrtles and other plants having smoother leaves.

Agriculture, in this country, is now much better understood and practised than it ever was at any former period. The patriotic example set by our beloved Sovereign, furthered by the Nobility and Gentry, has excited an emulation which has extended to all ranks of society, and the good effects, if not already felt, will, at some future day, much extend our resources as a Nation, and enable us the better to resist the encroachments of foreign enemies. The remains of decayed organized matter, the produce of our land, is better taken care of and applied to the purpose, as manure. But this is not all—foreign lands and seas likewise contribute towards the fertility of this envied Isle; for what eventually becomes of the greater part of our imports, such as fish, corn, tea, coffee, tobacco, cotton, wool, rice, sugar, wine, hemp, timber, &c.? All, that is not again exported, becomes manure at some period, in some shape or other; so that the soil of this country may be considered as annually increasing in fertility, at the expence of the nations with whom we trade: for the greater part of our own exports are not formed of organic materials, such as hardware, and the various kinds of porcelain; cotton and woollen articles, it is true, are of vegetable and animal origin, but the raw materials from which these are made, are principally *imported* articles. Any Nation that exports a large proportion of vegetable or animal matter, must impoverish the country in the same way that lands are sometimes injured by not expending the produce on the farm; and prudent proprietors, whose estates are situated near great towns, usually make provisions in their leases to return a quantity of manure to the estate for every load of hay or straw that is sold or carried off it. The greatest waste of manure in this country, is from the inattention to the valuable soil which might be obtained in large towns; a late improvement in the construction of water-closets, which refinement is now become very common, and undoubtedly adds much to comfort and cleanliness; yet, in an agricultural point of view, it is a serious loss to the community, as the most powerful manure yet known, is hurried into the common sewers, which, in the British metropolis, empty their contents into the Thames, and, in most other towns, find an exit by the assistance of some adjoining stream or river: like the *Cloacæ* of ancient Rome, which conveyed the very essence of the land into the Tyber. This was probably thought essential to health in a low damp situation, like that of Rome, and under a burning sun; but the Romans, ever awake to improvement and interest, did not neglect this part of rural economy; they did not, as we too often do, let those valuable juices run into the roads to the annoyance of the traveller, and which might be preserved for the improvement of the land; "*Sterquilinum magnum stude, ut habeas,*" was a good maxim amongst Roman agriculturists; and Pliny describes, while Columella recommends, the minutest attention to this indispensable point for increasing the produce of any country. From these ancients, however, though their practice may have differed from ours, and we may think ourselves far advanced beyond them in those arts essential to luxury and to life, much valuable information may be obtained; for it is too obvious to be denied, that, with all our boasting, there is, in our practice, a shameful negligence in this particular: and the slovenly appearance of a farm-yard, is too often the plain prognostic of the unproductive state of the farm. This is the more to be regretted, as it is proved by the discoveries in modern chemistry, that the material thus lost is of an highly phosphoric and oleaginous nature, from its animal origin; principles greatly conducive to vegetation.

The great importation of grain into England, since about the year 1770, proves, that, of late years, we do not, on an average, raise sufficient corn to support our population. The reverse of this was the case about fifty or sixty years ago; for we are told that, from the year 1743 to 1748, the sum of eight millions seven thousand nine hundred and forty-eight pounds, was received by us, for grain exported to other countries.—*(Chalmers' Estimate.)* A great part of the corn, which is now imported into the London market, comes from the north of Germany; more particularly from the Prussian states; and as these countries are situated in the same parallel of latitude as England, we may suppose that there has been no general change of climate throughout Europe, or they would not be able to spare any portion of their produce for us. Various are the causes, which have tended to produce the necessity of exporting corn; an evil which we have been obliged to submit to for the last thirty years, at the expence of a large portion of the national wealth. First, from a circumstance which proves the prosperity of the nation—an increased population; secondly, from one that must be deeply regretted—*an increase of pasturage beyond the proportion of tillage*; and thirdly, from one we trust not irremediable—*the coldness, cloudiness, and humidity of our climate*, rendering it less favourable for the fructification of corn and fruits than it was formerly. Our crops appear, it is true, more luxuriant to the eye than ever, and really are so, from the improvements in agriculture before alluded to; and if we could but have sufficient sun to maturate them, we should be equally satisfied with the *produce*, as we are flattered by the *appearance*. As seasons vary in all climates, so they do in ours, and the local causes which have such an unfortunate effect on our climate, are sometimes counteracted from adventitious circumstances; in which case we have a temporal abundance. I need not appeal to practical agriculturists, and ask whether they do not find the true wheat-lands *(the clays)* to yield a more abundant produce in dry warm seasons than in humid, and consequently cold ones? The fact is too notorious to admit of a question. We frequently find much valuable information orally handed down to us from our ancestors, in the form of ancient proverbs, both in prose and verse; I quote the following, not for the elegance of the poetry, but as conveying to us a very important truth:

"When the sand doth feed the clay,
Oh then, Oh then, a-lack a-day!
But when the clay doth feed the sand,
Then 'tis well for old England."

Meaning that, in humid cold seasons, the light, gravelly soils, yield the best crops, but yet insufficient to supply the wants of the nation; but in warm, dry summers, the produce of the clays are so much more abundant, that there is no danger of scarcity, though there might be a deficiency on the gravelly and lighter soils.

There is great reason to suppose, that the average produce of grain in England and Wales, which, from enquiries and observations, I have stated to be in the proportion of thirteen for one, is taken at the outside; and it is much to be doubted, if the last seven years have produced after the rate of this proportion. The year 1799 was very bad, and, two years out of three since, considerable districts have suffered grievously, either from the mildew, blights, or unfavourable weather during the bloom, which much reduces the average of this period; but, for the purpose of forming a fair comparison with the produce of a climate free from cloud, we will reckon our own *fourteen for one.* Now we find Egypt yields a produce, even under the present wretched management, from twenty-five to thirty for one; and we are told, if the agriculture of that country were properly conducted, it would, on the average, yield *thirty-five to forty measures* for one. Here, then, the effect of uninterrupted sun is evident; and though we cannot expect, in this northern climate, to obtain a produce adequate to this, owing to the number of plants which perish during winter, yet our Lenten grain may, perhaps, under favourable circumstances, in some seasons, nearly *average this proportion.*

CHAPTER VIII.

On the Influence of a cold humid Climate on the Animal Economy—Fashionable Stoves—Warm Rooms—Thin Clothing, &c. &c.

BEFORE I enter into a description of the probable means of restoring the climate of our ancestors, and yet retaining a sufficiency of land in pasturage to afford fodder for our sheep and cattle, it will be necessary, agreeable to my plan, to consider the effects of a less humid climate on the health of the inhabitants; this subject would admit a very extensive speculation of the most useful and important nature. Never having studied medicine as a science, I will not presume to think I can offer the votaries of Hygeia any thing new; but only recapitulate the observations of more able physiologists, with regard to the effects of heat and cold, dryness and moisture, on the human body; and if it has appeared, that these powerful causes produce surprising effects on the appearance and productions of vegetable nature, they will be found to operate as strongly on the animal economy. From the rapid advances made in physical knowledge, arising from the discoveries chemistry has made, towards developing the interior structure and elementary particles of bodies, astonishing results have issued, from numerous experiments made relative to these four states of the atmosphere; and it is still further evident that these states, and the sudden changes which take place in them daily, may all be resolved into the influence of one grand pervading and controuling principle, either in a latent or disengaged form, *Electricity*.

Meteorologists have observed, that the general range of the thermometer, during the summer months in England, at noon, in the shade, is, in cloudy or showery weather, from sixty-six to seventy degrees; and in bright, dry weather, from seventy to seventy-seven degrees; the highest degree of heat usually happens about two hours after the sun has passed the meridian, and the lowest degree of heat, or greatest cold, about one hour before sun-rise.

Our excess of cold in winter usually happens in January, and if a continued frost be attended with wind, the thermometer is seldom lower than twenty-seven or twenty-eight degrees; but in a calm night will descend so low as eighteen degrees, and has been known so low as eight: but such instances seldom occur. The endemial disease of this country, or that which foreigners style *our national plague*, is an affection of the respiratory organs, supposed first to originate, as its proximate cause, from sudden local inflammation, the consequence of previous torpor. This disease assumes various appearances in different individuals, agreeably to their respective temperament, and is so Proteus-like in its various stages, as to baffle the skill of the ablest physicians; even under the most flattering symptoms it often disappoints his hopes; seems to smile both at those who refer it to an asthenic, or a sthenic diathesis; and at those who recommend a phlogistic, or anti-phlogistic regimen—an acid or alkaline plan of cure*. This bane of our youth, and which makes such annual ravages amongst the *finest* and *fairest part* of *creation*, has been observed to have increased to a most alarming degree *within that period* which we have assigned for the material change in the climate of Great Britain. This complaint is generally preceded by what is termed a *cold*; an affection so common in our humid months and variable climate, as to be considered a thing of course, and, because unavoidable, to deserve little or no attention: and if you consult persons labouring under phthisis, they will invariably inform you that the first they perceived of it, was owing to a cold, which they supposed they must have taken on such or such an occasion. A common cold usually, if properly managed, ceases in a few days, generally in less than ten; if it continues beyond this period, medical advice should always be had recourse to, or serious consequences may be expected: and thus thousands, by a judicious method of treatment at the commencement of the disease, might be rescued from an untimely grave.—*Dr. Beddoes.*

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* The use of acids in Phthisis does not appear to be consonant to the doctrine that it proceeds from an hyperoxygenation of the system. If so, as their effects are owing to the action of oxygen, their use must accelerate the progress of the disease; and, according to Dr. Withering's observations, and those of other judicious practitioners, it never failed to aggravate the symptoms in what is termed *Phtysis hectica:* whether it be a different species, or a different stage of the disease, Florid Consumption. It must, with humility, be confessed that the opposite plan of treatment has been *equally unsuccessful*; and hence has arisen the discordant sentiments on the efficacy of remedies for this disease.

The subsequent effects of a cold, the febrile heat occasioned by previous torpor, are well known, and described by physicians; such as nervous cough, asthma, and consumption. Various causes have been assigned for the increasing prevalence of these distressing diseases in the present time, and, among others, the disuse of wood-fires, and the general adoption of mineral coal for fuel, has of itself been thought sufficient to account for it. But the great and sudden changes of temperature in our climate, are justly considered to be the cause of the frequency of such diseases in this country, not so observable in any other; and there is great reason to suspect that the warmth and closeness of our modern apartments, tends to increase the predisposition in the habit, and consequent liability to these complaints. In an economical point of view, as saving fuel, the ingenious contrivances of Count Rumford and others, undoubtedly are very efficacious for the purpose; as admitting a less frequent change of the air in the room, by the exclusion of the external cold air; but, by keeping the air of our apartments so much warmer than the external air, we are not only more disposed to fall into torpor on going into the open air; but, what is still more unfortunate, the increased action, occasioned by the newly-applied and increased stimulus, which consequently follows, when we return into our apartments, increases any predisposition for inflammation. And in this point of view, as still tending to magnify the evil, the *new-invented air-tight slides* for sash frames, air-tight shutters, sand-bags, double doors, with spring or elastic defensors; all calculated to obstruct every stream of air, however small, and insolate the persons within from the general body of atmospheric air, to which they must frequently be again suddenly subject, with less power to resist the certain effects of such a change; must, whatever our admiration of genius, and our love of elegance may dictate, be on the score of salubrity condemned. Our ancestors, on consulting the history of the country, were not so subject to these diseases, or to complaints, arising from debility, as we are, and they may have been said to have almost lived in the *open air;* for we find, on examining old mansions, as well as inferior houses, that the apertures of the chimnies were very large, and the windows and doors were badly fitted; so that when a fire was kindled, the change of air in the apartment must have been very rapid. A thermometer, placed in such a room, so that the direct rays of the fire might not fall upon the instrument, would stand but a few degrees higher than in the open air, owing to the easy communication between the air of the apartments, and the external air of the atmosphere; by the facility thus afforded for the transfusion and dissipation of heat: for transparent air is not heated by the rays of heat and light passing through it, but only in consequence of these rays heating the opaque bodies on which they fall, and these bodies again heating the air by reflecting the rays coming in contact with them.

Our ancestors contrived to keep themselves warm, by adopting a more judicious method to resist the cold and damp, that of clothing. The general use of flannel, the wadded stuffs for petticoats, and worsted stuffs, or brocaded silks for gowns, used by the females of other times, formed a much more secure protection from moisture, and resisted the cold infinitely better than the thin and diaphanous Grecian drapery of our modern females. The men, too, as appears by examining old records, illustrated by family pictures, wore their clothes much more full, and of a thicker texture than the scanty coats of half-milled superfine cloths, now so generally worn; and the *costume* of our chief magistrates, the fashion of which has perhaps not altered for centuries, seems well calculated for preserving warmth, as well as impressing the idea of dignity. The thick woollen dresses of the monks were admirably contrived for keeping in a due temperature the heat of their bodies, no part but the face being exposed to the external air; and this was again protected by the cowl, which well defended them from currents of air, at late vespers, or early matins during midnight, through the cold cloisters and vaulted aisles of monastic edifices. Our ancestors also, to preserve themselves from the effects of the currents of air, which necessarily pressed towards the fire-place, had recourse to the use of wooden screens or other fences, impervious to air, placed behind their seats. Such contrivances we meet with still in use, in large farm-houses, where the *seat* and *fence* generally constitute one piece of ornamental furniture; and however, in this fastidious age, when almost every thing is sacrificed to appearance, we may be disposed to think such things devoid of ornament; of their comfort and utility there can be little doubt. Round a large open fire-place in the winter, by this means they were kept warm from the direct rays of the fire falling upon their persons, while the air they breathed was little heated, owing to the rapid change affected by the ascending column of colder air over the upper part of the screen. Their lungs, therefore, did not receive such a sudden attack from the cold, when they went into the open air as ours do, when we instantly receive a shock by the change from our close-carpetted rooms. The sashed window, with double rabbets, was first introduced into this country from Holland, about one hundred and twenty years since; the pannelled doors are a later and more modern invention; and, to guard still more effectually against a change of air in our apartments, the apertures of our chimnies are so constructed as but just to take the smoke from the burning fuel. In the winter, when we leave such apartments to go into the open air, the sudden change of temperature we experience often amounts to twenty-five or thirty degrees; the entrance to the lungs and the glottis of the throat consequently fall into torpor, from the stream of cold air which is constantly passing between them for the purpose of respiration; and when we re-enter our warm apartments, the blood rushes with violence into those vessels, previously rendered torpid from the cold; and, like the pain our hands experience on coming near a fire after being exposed to cold, we feel a sensation of heat about the glands of the throat, this local inflammation spreads, and we find all the usual symptoms attendant on recent catarrh.

In opposition to this doctrine, the advocates for warm rooms say—look at the Russians and Germans; they experience this sudden variation in temperature to a much greater degree than we do, when leaving their stoved rooms for the open air, yet they are not liable to colds or catarrhs more than other nations. This may be the case; nor are we so liable to colds, when the air is in the same state in England as in Russia or Germany; that is, when it is some degrees *below the freezing point.* The atmosphere then becomes exceedingly dry, and is consequently a less powerful conductor of heat; as the humid particles are then frozen. Accordingly, when the thermometer is a few degrees below the freezing point, we do not feel so cold as when it is two or three degrees above; for instance, if we plunge our hands, and keep them in water, at thirty-four degrees of heat, the cold soon becomes intolerable; but if we expose our naked hands to air at this temperature, we do not perceive any such painful sensation: and for this reason, that air is not such a powerful conductor of heat. Count Rumford has shewn by experiments, that moist air more readily conducts heat than such as is dry. The same reasoning, therefore, is applicable to moist, or dry air, when surrounding our bodies in the months of November, December, and January. The thermometer, at this season, frequently stands in England, between thirty-two and thirty-five degrees, attended with great moisture, and we are very sensible of the cold; but when the cold becomes greater, all aqueous particles are frozen, a crust of ice being formed on the surface of the ground, evaporation is in a great degree prevented, and the air is found to be in a very dry state; the glands of the throat, and extremities of our bodies, are not then so liable to fall into torpor, and the injurious consequences arising from reaction, on coming into our apartments, are not so strongly to be apprehended.

Experience here uniformly agrees with theory; for we do not hear such a general complaint of recent catarrhs during *frosty weather*, as when the air is very damp and cold.

It has been stated, that the difference in the range of the thermometer, between a bright dry day in summer, and a clouded one, is about seven degrees; some persons might therefore be inclined to suppose, that any increase of temperature in summer, may predispose the body more to the reception of fever; but the reverse is the case; for we may confidently assert, that such a state of the atmosphere would tend to diminish the disposition to fever: since the atmosphere being in this case drier, we should consequently be less oppressed by heat, than on such occasions we usually are. We scarcely ever meet with a person who has experienced the effects of a tropical Sun in our East India settlements, who does not feel the sensation of heat in England, on a close, moist, clouded day, in the months of June or July, to be much more oppressive than that of India; the same remark has frequently been made by persons who have resided in Spain and Portugal: the difference is owing to the dry transparent state of the air, which generally attends the heat in those climates, and the humid cloudy state which, at this season, too often attends our own. When the air contains much moisture, the perspiration, so necessary to prevent the temperature of our bodies from becoming too high, is diminished; and we consequently feel oppression, arising from combined heat. But the moisture on our skin, at such times, it will be said, if we take exercise, appears greater, and therefore it may be inferred that we perspire more? No—the fact is, that the perspirable matter, in this state of the air, is not carried off the cuticular surface of the lungs with such rapidity as it is, when the air is drier; an accumulation of moisture, therefore, is apparent, and we feel oppression from the aggregation of obstructed heat: while the air is transparent, though the thermometer stands six or eight degrees higher, yet we feel alert and pleasant. When the atmosphere is in this state too, it very rarely occurs, that we have not breezes during the day from some quarter, which much facilitates the progress of evaporation from the surface of our bodies; and thus prevents our feeling the unpleasant effects we should otherwise feel by the increase of heat.

Islands and Continents, situated near the equator, vary much in regard to the salubrity of climate, from local causes, where the temperature is much the same; for if the heat is attended with humidity, we always find the inhabitants subject to virulent fevers, and to other malignant diseases arising from debility. The climate in Hindostan, and of other settlements in the East Indies, is represented as not unhealthy, except during the rainy seasons; when the intense heat being combined with great humidity, European residents complain and frequently suffer. Sir William Jones informs us, "his health was not much affected from that climate, except during the rainy seasons; and he very properly removed at these times, when his avocations would permit, into a part of the country where he could receive benefit from the breezes which came from the country of Thibet." *(Life of Sir William Jones, by Lord Teignmouth.)* —The country of Thibet is very high land, as well as mountainous; and, as Mr. Kirwan has shewn, such situations are colder than the standard, notwithstanding their vicinity to the equator*. European valetudinarians, residents in

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* This able geologist lays down a rule for ascertaining the mean temperature of any country thus—" Latitude 52°, mean temperature 50°; add one for every degree to the southward, and subtract one for every degree northward, and it will be near the truth. But as temperature not only differs, according to the latitude of a place, but also as to elevation; it is necessary to add another rule, which is—divide 15.577, the height of perpetual frost at the equator, by the difference of temperature above and below, and it will appear, that every 299 feet of elevation lessens heat 1°; and on dividing 5.162 by 299, we have 17, which, sub-

India, should avail themselves of this information; for, by a short residence in the country of Thibet, they might recover their health sooner, and much more effectually, than by a tedious voyage for that purpose to Europe.

The neighbourhood of Batavia, in the Island of Java, is said to be particularly unhealthy. Many circumstances, agreeable to our theory, are here combined, to render the air remarkably humid, and, of course, unwholesome; it is situated in a low marshy plain, at the union of several small rivers; and in most of the streets are canals filled with stagnant water. These canals extend into the country, and their banks are shaded with lofty spreading trees; the exhalations of which contribute to increase the humidity of the climate, and prevent a free circulation of air. Accordingly we find what, under such circumstances, might be expected, that the inhabitants are very subject to highly-malignant fevers, and other epidemic contagious disorders, the effects of which are so visibly marked, that every countenance betrays symptoms of languor and debility. The following instance shews the

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tracted from 69, mean temperature of latitude 32, gives 52 for the temperature of the *Serra* in the Island of Madeira: and which is a confirmation of the theory; the same plants are found growing there as in the level country, whose latitude is 50°.

uncertain tenure of human life in this climate, which is given by Dr. Thunberg, in his Travels through Asia, published in 1795. Shortly before his departure for Japan, he sat down at table in the house of his friend, Dr. Hoffman, with twelve other persons, and, on his return, in an interval of *only three weeks*, he found that eleven of them had been carried off by fever; so that Hoffman and himself were the only survivors out of thirteen. The annual register of deaths is said to have received a most rapid augmentation after the cutting of an additional canal in 1733.

The West India Islands again present a melancholy picture of diseases, in consequence of a hot, humid atmosphere. The highly contagious disorder, called the *yellow Fever*, which lately has committed its ravages in the eastern as well as western hemisphere, is supposed to be entirely owing to this circumstance. The same disease appears occasionally in the southerly provinces of North America, though every precaution appears to have been adopted to guard against its importation. In the numerous discussions which this disorder has lately produced, we are sorry to observe such opposite opinions respecting its precise nature—opinions which could only arise from the pride of science, and the desire of singularity, and which must produce an unpleasing effect on the mind and practice of the public; inducing a belief that precautions to prevent the spread of it are, either nugatory, or unnecessary; because it was observed that the yellow fever of America did not affect persons far beyond the atmosphere of their cities, some medical men concluded the disease not to be of a contagious nature; and, in Spain, because that a few who were attacked recovered by an immediate removal to the country. Some of the Spanish faculty drew the same conclusion, which led them to neglect numerous means of prevention within their power. The physicians of Cadiz gave their opinion in favour of its contagious nature, and the result was obvious. However, it is useless to enquire whether the contagious miasmata can be conveyed, or how far, by the aerial fluid; when it is acknowledged, that it is a particular constitution of the atmosphere which produces the invasion, accelerates the communication, and renders the consequences so fatal.

While the medium is so extensive, we should turn our attention to the prevention, and correcting the atmosphere, both in diseases arising from general, or specific contagion. The heated air brought with a south-west wind, from the gulph of Mexico, must be highly charged with humidity; and the same circumstance happens with a south-east wind coming from the western Archipelago; but the atmosphere being drier in the interior parts of the country, owing to its passage over the mountains and barren grounds of these districts, the inhabitants are less liable to be infested with this western plague, than those situated in the towns on the coast. The Americans have acted wisely, therefore, in removing the seat of government into the interior; and they will probably find it necessary hereafter to abandon the large towns on the coast altogether, save a few important Sea-ports. The interior of Spain possesses, for the most part, a dry transparent atmosphere, having a large proportion of uncultivated land, which has a very slight vegetable surface; consequently, except during the rainy seasons, there is but little cloud, and though the summers are very hot, the inhabitants are generally healthy, with the exception of those inhabiting towns on the southern coast, where humid air is produced by their vicinity to the sea. In these parts, towards the end of the summer, we find that a hot humid atmosphere prevails, and the inhabitants of Cadiz, Malaga, Gibraltar, &c. are often visited by epidemic and contagious fevers. As Spain and Portugal are liable to suffer in summer from excessive drought, the English system of inclosing the country, and intersecting it with living fences and trees, would probably occasion a more vaporous atmosphere, which would produce thunder storms, more frequent Irrigation, and obviate, in a degree, the evil complained of; but it is much to be doubted if it would then be so healthy as at present, and it would certainly render their Vintage much more precarious.

The warm humid air experienced in Italy, Sicily, and Malta, called the *Sirocco wind*, proceeds in a south-east direction from the hot burning sands of Africa; it is said to be most frequent in the month of May, which agrees with observations made in Egypt; for the *Ramsin*, or destroying wind of the desert visiting the shores of the Nile at this period, proves it to be the same as the *Sirocco wind* in Italy. When it first leaves the shores of Africa, it is an exceedingly dry parching wind, loaded with particles of sand; but, in passing over the Mediterranean, it seizes the vapour arising from the surface of the sea, and deposits the sand, which it had before taken up; and, on its arrival on the shores of Italy, it there becomes a heated wind, charged with abundant moisture.

Mr. Brydone, who experienced a Sirocco wind, while resident at Palermo in Sicily during the month of July 1770, informs us it came in a southerly direction, and the thermometer previously stood at 72; but, upon his going into the open air in the morning, at eight o'clock, he was exceedingly astonished at the sudden change of temperature. The first blast on his face felt like the burning steam from the mouth of an oven, and on exposing a thermometer in the open air, it immediately rose to one hundred and ten; and soon after to one hundred and twelve degrees. After remaining a short time exposed to this heated atmosphere, he found he could bear it more tolerably than he first expected, being relieved by a most copious perspiration; the air was thick and heavy, the sun being obscured the whole day. This extraordinary heat continued till three o'clock in the afternoon, when the wind changed at once to the opposite point of the compass, blowing strong from the north; and, in a short time, the thermometer fell thirty degrees. This extraordinary wind is said to last in Sicily seldom more, than from thirty-six to forty hours, during which time the inhabitants confine themselves to their houses, and employ their servants constantly in sprinkling water through their apartments, to preserve the air as temperate as possible. This singular heat has not been found to produce epidemic disorders, and the only inconvenience the inhabitants sustain, is a temporary debility, from an exhaustion of strength, which they shortly recover; and when the north wind has blown for a few hours, it soon restores them to their usual state of tone and alacrity. But the heat is totally different at Naples, and in other parts of Italy; the heat at these places is not near so violent, but it lasts many days, nay even weeks; is often attended with putrid disorders, and never fails to produce languor and dejection of spirits. This wind, coming in a south-easterly direction, has a considerably greater distance of Sea to pass over from the coasts of Asia and Africa; the temperature is by this moist passage moderated, and its humidity increased.

We are subject in England to a wind which, in some respects, resembles the Sirocco wind of Sicily, though the variation in temperature with us is not so considerable; it sometimes happens towards the end of April, but most commonly in May, the medium height of the thermometer in the morning and evening being usually about forty-five, with variable winds; the barometer falls, and the wind frequently becomes stationary at south-west or south; blowing briskly, the air is soon conveyed to us from the countries bordering on the bay of Biscay, and off the western coast of Portugal; the thermometer rises to fifty-nine or sixty, and even to sixty-five, attended with great humidity: the previously cooled walls of our houses, and stone floors, condense the vapour, which appears in trickling drops; we feel oppressed, and if we take exercise, a considerable debility, with a sense of fullness about the head, never fails to accompany or follow it. When this wind ceases, it is immediately succeeded by a wind from the opposite point of the compass, i. e. north-east, and the temperature soon lowers again to about forty-five degrees: this wind, like the Sirocco in Sicily, may be accounted for on very obvious principles. Previously to the setting in of the southerly current, the barometer falls; this wind, therefore, cannot be owing to an expansion of air to the south of us, but to a condensation and precipitation of vapour in Norway, Sweden, or the North polar regions; which, diminishing the specific gravity of the air in those places, air will rush in from the neighbouring parts of the atmosphere, to restore the equilibrium; the barometer will therefore fall in the countries adjacent to the south, because the pressure of the atmosphere is lessened, owing to the portion of air drawn off by the deficiency of atmospheric gravity in the north. This stream, or portion of air, being formed by the condensation and precipitation of vapour in the north, or north-east, will, from the above reason, occasion a southerly wind, with a depressed barometer, till the equilibrium is perfectly restored; the wind will then cease, and the consequences of that calm will be, the warm air which had been passing in an horizontal direction, at a temperature of fifty-eight or sixty degrees, and specifically lighter than the medium in the north, as soon as the current ceases, will ascend, and we experience the stream of air pressing in, and passing under it from the north-east. Supposing England the centre of the southerly stream, the returning current of cold air will proceed from the opposite point of the compass; but an observer in Norway would experience an *easterly* variation; and a ship sailing between Ireland and Iceland, a *westerly* variation. Whoever has noticed the weather in this climate, during the month of May, cannot but have often remarked this phenomenon, as there are few seasons in which it does not strikingly occur.

The Islands of the Grecian Archipelago, and the shores of the Bosphorus, Syria, and Egypt, experience at times a hot and very humid atmosphere; they are therefore liable to epidemic and contagious disorders. A fever, which they frequently experience, seems to be attended with very *peculiar symptoms*, and to be totally different to that of the western Archipelago, though probably arising from similar causes, so far as the disposition of the atmosphere, in its production or prevalence, is concerned; this dreadful malady is called the *plague*. It is an opinion generally admitted, that, during the prevalence of epidemic or contagious diseases, out of the number of those most exposed to the contaminating virus, some escape; but this observation does not peculiarly apply to such maladies—for similar instances may be adduced, not only in the plague but Hydrophobia, inoculation, and diseases newly received by contact, as Psora, Lues, &c. This has been supposed to arise from a constitution diametrically opposite to the nature of the disorder they escape.—*Vid. Memoir in Act. Petrol.* 1776. Happy for the world would it be, if we could, by any means within ourselves, obtain that disposition which would, in all cases, repel the virulent influence of such disorders!

It certainly appears, that a predisposition in the habit will subject one person to the effects of contagion, while another shall escape in *the same place*; but it is highly worthy of remark, that, in the malady which raged in Cadiz, the writers have stated that different states of the body have a more particular predisposition to receive the action of contagion; for it is well known that the plague does not always break out in those places into which the pestilential matter has been imported. It is also ascertained, that a certain state of the atmosphere is necessary to favour its appearance, and further its progress; and that it never is known to commit such cruel ravages, as when the atmosphere is in a state favourable for the developement of its poison. The opposers of the doctrine, who say that the effects of contagion are in a great degree subordinate to the predisposing causes, might be asked, if the malady is not visible in close confined places, hospitals, prison-ships, populous confined cities, and at a time when the atmosphere is most accompanied by heat? All which circumstances indicate, that causes which produce debility, are predisposed and favourable to contagion. All concur to prove it is owing to the diminution of the vital power, and nothing tends more to diminish the vital power than a moist, hot, and cloudy atmosphere; that habit will go a great way, and that much depends upon being used to certain states of the air, is equally evident. During the sweating-sickness in England, the Dutch, resident here, were remarked generally to escape, who had been accustomed to a damp, close atmosphere; and the yellow fever is constantly fatal to Europeans, while the natives suffer little from its ravages. Even in manufactories, abounding with putrid exhalations, as skin-yards, &c. the workmen, constantly breathing an air which would be highly prejudicial to the health of those unaccustomed to such an employ, feel no inconvenience; and the account of the *yellow fever*, that which raged lately in Andalusia, is illustrative of this, especially respecting some foreigners in whom habit seems happily to have bestowed a disposition to resist the contagion. The physicians of Cadiz observe, that the constitution of the atmosphere, as to heat and moisture, had been, during the preceding summer, similar to what annually prevails in the *Antilles*; hence it is obvious how those lately arrived in Spain from those Islands escaped; because, habituated to a similar state of heat and moisture; while the inhabitants of Cadiz fell victims to the disease from an *inverse* cause.

The force of habit even to resist the virulent effects of poison, has been observed as early as the time of Hippocrates, who, in his aphorisms, gives this judicious advice; not to change even from pernicious habits, but by a gentle transition, to those that are salutary. Yet habit cannot exert a chemical change on the floating miasmata, though it may produce a predisposition to resist their action on the system; they still exert the same wherever they are found, and on the air they principally must depend for developement; and that, under the same prevailing state, is highly favourable to their increased and multiplied effect.

Moral causes have been urged by others as producing similar predisposition; but this has subjected the patients to other diseases not at all analogous in their types. When the state of the air has not been deteriorated by contagious effluvia, and favoured by the circumstances here alluded to, from the predisposing state of the atmosphere, and its actual state favourable for developement and propagation; we must look for the baneful effects produced by these malignant and pestilential diseases in the discoveries of chemistry for the spreading of contagious matter, and to philosophy for the means of counteracting this power, and removing the causes which give rise to it. When we are unable to remove from a country, where these circumstances occur, and removal often proves ineffectual, the only object to keep in view is to support and augment the vital force; and this is best done, as M. Guyton de Morveau has amply demonstrated, in his admirable treatise on the best means of purifying infected air, by *oxygenats*; which possess that property in the highest degree; for if infectious miasmata are not of an alkaline nature, ammoniac is always found in combination, and probably is the vehicle of those destructive particles. After the various modes which have, in different eras of our knowledge, been adopted, as the burning of perfumes, alkaline washes, acetous sprinklings, &c. &c. and even after the method of applying the nitrous gas, for which Dr. Carmichael Smith obtained such distinguished patronage in 1802, the *superoxygenated muriatic gas,* first introduced to notice by the ingenious Dr. Johnstone, of Worcester; and its invaluable properties in destroying contagion in the malignant gaol fever, which broke out in that city 1756, and on subsequent occasions, is decidedly the most efficacious: of all the mineral acids, this has been found the most salutary, safe, and easily applied. The fume arising from burning sulphur, or vitriolic acid gas, destroys putrid miasmata wherever it comes in contact; but its power is confined, owing to its fixity, and it cannot be employed where persons are present. The nitrous acid gas, or white fumes produced by the method recommended by Dr. Smith, produces a stronger effect, but it extends not far, and condenses quickly. The oxygenated muriatic gas furnishes us with all we can wish for this purpose, on account of the great expansibility and the ease with which it may be applied; the safety of its application, and the cheapness of the ingredients.—*Vid. Morveau on Infected Air.*

The plague is said to be most common in Egypt after the inundation of the Nile; a quantity of slimy mud being left, occasions a humid mephitic exhalation to arise, which, Dr. Wittman is of opinion, generates the contagion; and, from the account of the diseases of Egypt, related by Sir Robert Wilson, there is great reason to believe, that a humid state of the atmosphere is favourable to the production of this dreadful disorder; for the English and Turkish armies, which marched to Cairo, escaped contagion, notwithstanding almost every village was infected; while the troops, which remained stationary on the moist shore at *Aboukir*, were severely afflicted, and lost one hundred and seventy-three persons. A dry atmosphere appears not only to be a preventive of plague, but to afford a remedy likewise; for we are told that several men, confined with this disorder in the hospital at Jaffa, escaped into the desert, and endeavoured to reach the army; but, finding the attempt impracticable, returned in three days perfectly recovered.

The effects of a dry climate, although attended with extreme heat, are very conspicuous on the persons of the wandering *Arab tribes*, who spend the greatest part of their time in traversing arid sandy deserts; perhaps no men on the face of the globe possess the *mens sana in corpore sano* in a higher degree; they are said to be endued with uncommon activity of mind and body, and to endure fatigue and deprivation of aliment with little apparent inconvenience. Now the usual effects of a warm climate are the very reverse; the body and mind in general partake of debility, and men are disposed to lose their activity and sink into indolence and effeminacy: this exception of the Arabs, then, can only be attributed to a greater purity of climate, as there does not appear to be any other physical cause. The quantity of aqueous moisture that is dissolved in the air which we constantly respire, must doubtless have a considerable influence on our constitutions; as, in addition to the decomposition of air, which takes place in the act of respiration, there is great reason to believe, that a process is likewise going forwards excretory of aqueous moisture, similar to that from the leaves of vegetables; for we find that those unfortunate persons, who have been deprived of food and liquids, when shipwrecked, or buried in coal-mines, have always complained of intolerable thirst. And if we direct our breath on a cold plate of glass or metal, we always find, that there is a deposition of moisture, which appears to have been taken up from the moist surface of the lungs; for if the pipe of a pair of bellows be heated in the fire, and air then forced through the pipe on cold metal or glass, no moisture in this case will be deposited: and as the atmosphere we breathe is occasionally varying with respect to dryness and moisture, we must be liable, if our lungs are excretory of aqueous moisture, like the leaves of vegetables, to experience a change of health, agreeable to such variations in the atmosphere. What favours this idea is, that we do experience a very sensible effect by these variations on our state of body; for when the wind has blown from an easterly, or northerly point, with a dry state of the air, we feel alert and strong; but if the wind suddenly changes to the south-west, a warm close air, replete with humidity, is soon brought to us from that quarter. The air then being nearly saturated with moisture, a much less quantity of aqueous fluid is taken up from the surface of the lungs; the blood-vessels consequently become turgid, and the vital fluid is probably rendered less stimulant; we feel oppressed with a sense of fulness, particularly about the head, which is sometimes attended with giddiness and languor, and invariably with some debility. When the air is dry, and the wind northerly, or easterly in the spring, we may at any time artificially feel this sensation by going into a conservatory, where the air is raised eight or ten degrees above the external temperature; particularly if there be a number of luxuriant vegetables, or if the floor be kept moist, or a portion of steam introduced; we then soon experience this sense of fulness about the head; but if we put our heads out at the window, or introduce a tube, connected with the atmosphere without, so as to breathe the external air, the unpleasant sensation subsides, although the rest of the body is exposed to the warm humid air.

An excessively dry atmosphere, it might be imagined, would be highly injurious to animal, as well as vegetable life; but it seems to derange the economy of the latter much sooner than the former. A wind of this kind is occasionally experienced on the western coast of Africa, between the equator and fifteen degrees North latitude; it blows from the north-east towards the Atlantic ocean; hence it must come over an extensive space of very arid land; it is called by the inhabitants on this coast the *Harmattan.* The following account of this wind is recorded in the Philosophical Transactions, by Mr. Norris:—"A fog or haze always accompanies this wind with extreme dryness; so that vegetables of every kind are very much injured, and all tender plants, and most productions of the garden, are destroyed. Although this wind is so very prejudicial to vegetable life, yet it is highly conducive to health; those labouring under fluxes and intermitting fevers, generally recover during the blowing of the harmattan; and those weakened by fevers, and sinking under evacuations for the cure of them, particularly bleeding, which is often injudiciously repeated, have their lives saved and vigour restored. It stops the progress of epidemics; the small pox, remittent fever, &c. not only disappear; but those labouring under these diseases, when an harmattan comes on, are almost certain of a speedy recovery: infection appears not then to be easily communicated, even by art."—*Philos. Trans. vol.* 71.

The difficulty of communicating infection to animals, during a dry state of the atmosphere, as remarked on the western coast of Africa, during an harmattan wind, agrees with the late observations on plague, by the French physicians; as this complaint first made its appearance in the French army, during a moist state of the air in Syria, when the army lay under the walls of Jaffa, in February 1800. And M. Assalini remarks, that the attendants in the hospital at Smyrna, rarely took the infection if they avoided the breath of the infected persons.—*(Vid. Assalini's Obser. on the Plague.)* Is not the poisonous matter of plague, and other infectious complaints, united with the water of the atmosphere; and is it not thus conveyed from one person to another? The scent of flowers and other odoriferous matter, is most perceived, when the air is humid, during the fall of the evening dew; the stench of putrid ditches and common sewers, is conveyed to the nasal organs much more speedily in Summer, previous to rain, when the air is damp.

The reason why vegetables are so much more injured during a very dry state is, that they cannot hastily absorb more moisture by their roots, to supply this profuse perspiration. Hence we find the leaves of cucumbers and melons, that have had the organization of their leaves extended to the utmost limit, for want of sun and ventilation, by being planted in glass frames, if they are exposed suddenly to the sun and open air, the exhalation becomes greater than the roots can support; and the vessels being thus emptied, the plants become flaccid, wither, and die. But similar vegetables, which have been raised in the open air, do not extend their organization so far, and the leaves, being of smaller dimensions, suffer but little inconvenience from such changes; more especially if the weather has not been previously long cloudy: but if, after a long clouded season, the Sun suddenly breaks out in the middle of the day, we then find the extremities of our potatoes, cabbages, and other vegetables fade, like melon and cucumber plants growing in frames, when suddenly exposed to the sun and air. The appearance of the Acarus, or *red* spider*, so destructive frequently to our hop plantations, and the pest of our graperies and melon frames, is owing to this cause, which produces a disease on the leaf by inspissating the vessicular juices, and consequently obstructing circulation. Various vegetables, in our climate, are thus, by the too powerful action of sudden light and heat, often materially injured; and that at a time, when the hygrometer does not indicate an extraordinary dry state of the air; but the extended surface of the leaf, and accumulated excitability of the plant, during the previous cool clouded state of the atmosphere, occasions a greater expenditure of moisture in the leaves and tender shoots, when the sun thus suddenly bursts forth, than the plants can support. Having thus shewn by comparison the different effects of a dry and moist atmosphere on the human constitution, it will appear we shall have little cause for apprehending dangerous consequences to our health, by restoring the spring and summer climate of our ancestors; but, on the contrary, we hope posterity may regain the constitutional vigour which our progenitors possessed. I shall now proceed to notice the probable effects of a less clouded sun on the *pasturage* of the country.

CHAPTER IX.

Effects of a less clouded State of the Atmosphere on the Pasturage and other Vegetables—Recommendation of substituting other Substances instead of Hay, for feeding Horses, &c.

ENGLAND has ever been celebrated for the produce of its pastures, since a humid clouded atmosphere is favourable to the increase of vegetable foliage, though not to its fructification; consequently more and broader leaves of grass are formed in wet and clouded seasons, to enable the plants to produce sufficient nutriment for the formation of their seed; but graminivorous animals, when fed on the grass, do not thrive in proportion to the *quantity* but *quality* of the food they eat. The grass, in such seasons, contains much less saccharine matter; and the animals feeding on it are obliged to receive a larger portion to satisfy their appetites, as this poor watery food quickly passes through their intestinal canal, and is soon evacuated. And where sheep and cattle are fed on such grass, we observe that they are almost perpetually eating; but, on the contrary, in moderate dry seasons, as every blade of grass contains so much more proportionate nutriment, a considerable less quantity suffices, and we then observe the same animals, a great part of their time, lying down, and ruminating in the shade: the excrementitious part is longer retained, and, when evacuated, is found more solid in consequence of more perfect digestion. I have endeavoured to learn from graziers and butchers, whether animals, slaughtered in the Autumn and early part of the Winter, after a moderately dry season, die leaner than after a wet season, when the quantity of grass has been more abundant? The answers I have uniformly received are, that they die best after moderately dry seasons, provided care has been taken to supply them with a sufficiency of water—that is, they weigh better, and the meat is more firm; but, after a wet season, the beef and mutton wants that firmness, or solidity of flesh and fat, which constitutes good meat; and, in the technical phrase, is *squash*, like the food on which the animals have fed. It may, perhaps, be a question, whether fewer animals are fed in a dry summer than in a wet one; but, judging from the effect on the market, I should not suppose the number varied much, as we do not find the meat market fluctuate, as the corn market does, after dry or wet seasons.

The only crop that would suffer any considerable diminution by an increase of dry warm weather in the early part of the summer, is the *hay*; that is, there would be less bottom grass, as it is called; because the parts of fructification, in such cases, may be supplied with nutriment by fewer leaves in dry warm weather; but there is great reason to think, that the number of flower stalks would not be diminished, and this is the most nutritive part of such crops; for we are informed the second crop of hay, which is sometimes obtained in the neighbourhood of the metropolis, and other places, and called *rowen*, consists almost entirely of the leaves of grass, with very few flowering stems, which is far less nutritious than the *first crop*. And it is stated by experienced milkmen, that a cow will require one *third more of this second or latter math hay, to support herself*, than she would do if fed with hay of the vernal produce, which proves clearly, that the greatest portion of nutriment is contained in the seed stalks. The fermentative process, which hay undergoes in the stack, converts a part of the mucilaginous matter, contained in the leaves and stem, into a saccharine substance, provided the grass is cut at the proper season—that is, when the greatest number of seminiferous blades are in flower. This point is worthy of more attention than it generally receives; for if the seed is allowed to be perfected, the stems become dry and brittle, very little better than straw, the saccharine substance having then perfectly disappeared. The degree of fermentation which takes place in the stack, too, depends on the degree of dryness or moisture, when *ended*, or placed there; for if too dry, little fermentation will take place; and if too moist, the process will proceed with too great rapidity, and the heat, generated by such a violent fermentation, will occasion a partial decomposition of the saccharine and mucilaginous matter; a portion of the hay approaches to the state of charcoal, and is said to be *burnt*. Such fodder is considered very unwholesome for *horses*, although cows will eat it with little apparent inconvenience. Graziers, who adopt a rational system of feeding, are peculiarly careful on this subject, and would even *rather risque a portion of their annual stock of fodder, by being put up too green, and becoming mow-burnt, than have the whole ended too dry*; stating that the loss thus sustained is comparatively trifling to what they should suffer by their cattle being fed on hay, whose nutritious juices had been previously dissipated by growing too late, or being left too long in the field, exposed to the Wind and Sun. This partial evil may always be avoided in dry seasons, at the time of making, but cannot, without difficulty and inconvenience, in wet ones.

It would be useful if this process for increasing the nutritious matter, contained in green vegetables, were to be further enquired into, and experiments performed to ascertain the comparative nutritious substance thus obtainable from *different kinds of vegetables*, and in *different states of growth*. The varieties of maize, or Indian corn, all contain a very large quantity of saccharine matter, previous to the formation of the seed. This plant, of the dioecious Class, I have found by experiments, contains this material most abundant in the *stalk*, at the time when the staminiferous blossoms first appear; perhaps if it were then cut, and made into a sort of hay, it might afford a very valuable winter fodder; as the plants will thrive very well in this country, although we have not sufficient warmth to enable them to effect their complete fructification. The quantity of nutritious fodder yielded by an acre of Indian corn, in a green state, or if it could be made into hay, there is reason to think, would be immense. If consumed green, it would come into use in that period of the summer, when there is often a scarcity of green fodder; and the land being ploughed for it late in the spring, there would not be much exhalation from such a crop, till towards the time, when the common hay is removed; and therefore would not be, like many early luxuriant crops, injurious to the climate: indeed many species of arundiferous plants might profitably be adopted for culture in this country, even from countries much to the southward, as they will grow, though not *perfect, their seeds here;* and, if cut in a green state, are the most rational and economical sort of fodder, as they contain a larger portion of the pabulum of life than many of the grasses usually reared for the purpose. A species of reed, we are informed, is cut in a green state by the inhabitants of Kamschatka, and allowed to undergo fermentation; after which the quantity of saccharine substance is found so abundant, as even to appear on the stems in a crystalized state.

It is certain that, in the process of making hay, if well performed, it will be found that the nutritious matter is increased by the partial conversion of the cruder mucilaginous sap, into a substance analogous to sugar; as we find that animals thrive faster with this food, and prefer it to that, which withers, is left on the ground, and found in the winter in a state of self-made hay. In viewing the state of grass lands in this kingdom, we are astonished to find that a practice, which, in some countries, is termed *fogging*, and in others beating the land should be suffered for one season longer, in the present state of agricultural knowledge; that it covers and feeds the young grass, and increases the future crop, is too idle a story to deserve serious refutation; if it prevents the free access of sun and air, it must obstruct growth: and every petty gardener will inform you from experience, that, by removing decayed and superfluous stems, you strengthen the roots of plants. That it affords fodder for cattle, at a critical period, is still worse reasoning; for the bents, or blades, thus long exposed, after the sap has left them, to all weather, become insipid, and much worse than the worst straw, which has been more rapidly dried; for if it had been cut before the sap had entirely left it, would have produced a great quantity of more nourishing food; not to mention the injury land receives by treading at this season of the year. The exceedingly nutritious fodder, hay, is shamefully wasted by the improper way it is commonly made use of, for the support of our *draft* as well as *carriage* horses.

We seem to have fallen into the same error in feeding them, as in feeding ourselves; *that of combining too much nutriment in too small a space.* The stomach of biped, as well as quadruped animals, are thought to be capacious in comparison with their size, and require to be furnished with substantial, as well as nutritious food, to distend them, without which the process of digestion is rendered incomplete. Highly concentrated nutriment, being contrary to nature, when taken into the human stomach, rarely fails to derange the digestive faculties; after taking such kind of food, *fermentation*, instead of *digestion*, takes place, and we feel oppressed by a sense of wind, acidity, &c.: If a healthy subject satisfies his appetite with a due proportion of plain food, as bread, meat, and potatoes; he rarely after eating complains of indigestion; but if his hunger is appeased with highly concentrated nutriment, such as chocolate, butter, cream, sugar, sauces, without a due admixture of bread, potatoes, and other less nutritious aliments, the immediate effect of such food is generally sickness, heart-burn, head-ache, or some of the various ailments attending a disordered state of the stomach. Nature very sparingly produces food in a very concentrated state; the saccharine matter, found in esculent fruits, is generally blended with some acidulous, or mucilaginous materials, which, being easily assimilated, when taken into the stomach, become wholesome nutriment; and the oleaginous matter does the same with the farinaceous, in seeds, kernels, and other substances of this description. If we would wish, therefore, to preserve health unimpaired, we must imitate nature in our kitchens; then would the culinary art, instead of being a curse, become a blessing to mankind: by multiplying our resources in the time of scarcity, and the emergency of Famine. The capacity observable in the stomachs of graminiverous animals, evidently shews, that they were designed for the reception of a large quantity of food, and not for such, whose quality is of that kind in which the nutritive matter is concentrated. Numbers of our horses are fed with hay, oats, and beans, the nutriment of which is condensed into a much smaller space than it could generally be in *natural* provender. These animals, when supported on such food, are consequently liable to various ailments, originating from diseased action in the stomach, or from plethora in the system; and hence arises broken wind, (as it is called) running at the heels, yellows, or jaundice, staggers, or apoplexy, &c.; in short, horses so fed, and unnaturally confined in stables, require to be bled, purged, or constantly exercised, to preserve their health. These useful animals, thus abused, evidently suffer from heart-burn; as we find they frequently eat absorbent earths with great avidity, after being kept months on this unnatural food; and if we were acquainted with their sensations, there is little doubt but we should find they suffer from many diseases analogous to those of human beings. The extraordinary exertions often required of horses, render it necessary they should be better fed, than when existing in a state of nature; and finding they do not travel so well upon a full stomach, it is requisite to adopt the use of food in which the nutriment is reduced into a smaller compass. Post-horses and others, whose motion must be rapid, are therefore chiefly fed with *corn only*; but this mode of feeding horses, like all other deviations from nature, is productive of inconvenience and disease. Before we give our perfect assent to such a system, we should ask ourselves this question—Suppose a horse to be living in a state of nature, and allowed the full range of a country, where the gramineous and leguminous vegetables, are indigenous to the soil; as he possesses no power of separating the chaff and straw from the grain, he consequently would feed indiscriminately on *both*; the wisdom of the great Creator has endued this animal with digestive organs, peculiarly formed for extracting the nutritious materials from the food in its natural state. Reasoning from analogy, therefore, we may compare a horse, fed on *corn only*, to a human being fed on *butter* or *sugar*, without other admixture of viands; and the effect on the stomach of both must eventually superinduce irregularity, and consequent disease, Would the strength of an athletic peasant be rendered greater, think you, by being fed with such dainties, as cream, butter, sauces, or sweetmeats, without an admixture of more simple ingredients? No; on the contrary,

> "————The prudent taste
> Rejects, like bane, such loathsome lusciousness;
> The languid stomach curses e'en the pure
> Delicious fat, and all the race of oil:
> For more the oily aliments relax
> Its feeble tone." ARMSTRONG.

The intolerable fetid odour, perceptible, when post-horses are fed with oats and beans only, cannot have escaped the observation of travellers, as our olfactory nerves frequently suffer, especially if the poor animals are subject to an impaired digestion; then the odour of sulphurated hydrogenous gas becomes very powerful indeed. The digestion of this fermenting mass, I am disposed to think, would be much assisted by mixing at all times an equal quantity of chopped wheaten straw with the corn, which would enable these unfortunate animals to drag the rattling lumber affixed to their shoulders with greater ease and comfort than they at present do. The chaff for horses should not be cut too small—if so, it is swallowed without mastication, less nutriment is consequently extracted, and is with more difficulty digested for want of a due proportion of saliva. Four-fifths of the hay, now used in our stables, might be saved by a more judicious method of feeding horses; and many thousand acres of the best grass land might thus be rendered ten-fold more valuable to the public. Post-horses, and those used for drawing stage-waggons, as they require to be hastily fed, will sooner fill their stomachs with cut provender; but horses allotted for the purposes of husbandry, the army, or private use, might, when convenience served, be fed with oats or other grain *unthreshed*, or in the straw, for the reduction of necessary labour, which would be no inconsiderable saving annually to the community.

I recollect, some years since, expressing to a friend my doubts respecting the propriety of feeding horses constantly with hay, and, in return, received the following particulars. He informed me, that two persons belonging to a celebrated *Hunt*, were always observed to possess horses of uncommon activity and strength; and that these horses regularly quitted the field, after a long chace, apparently less fatigued than those of their neighbours. The *Squire Westerns* of the Hunt consequently enquired, for the benefit of Nimrodism, how these horses were fed? And the result of the enquiry was, that their food consisted of oats and wheaten straw, without any allowance of hay whatever. I have thus been prolix upon the subject of feeding horses without hay, because it is one method among others, which may be adopted with the least inconvenience to the country for diminishing the surface of grass lands, and as tending to restore a reasonable proportion of *Tillage*.

CHAPTER X.

On the probable Methods of ameliorating the State of the Atmosphere at the Season complained of —Reduction of exhaling Surface—Quantity of Evaporation from various Kinds, &c.

HAVING taken a view of the probable advantages, which both animal and vegetable life would experience by lessening the vapourous atmosphere in the Spring and early part of the Summer, producive of those frosts and blights which are so prevalent at this early part of the season, and which prove so injurious to our crops; I shall proceed to a description of the probable methods of effecting this invaluable object. Here it may be necessary again to remind my readers of the remark already made, that Agriculture improves a climate disposed to humidity and coldness, only by reducing the quantity of evaporating surface; in consequence of which a less cloudy sky is formed, and the solar rays are admitted to warm and defecate the earth, which is highly conducive to salubrity. This amelioration is effected by draining morasses, and felling and clearing forests; as the grain and other vegetables, cultivated on the surface thus changed, causes it to exhale much less aqueous vapour, than it did in its previous state of wood or morass. The general produce of this renovated surface, it should be recollected, exhales moisture *only during a part of the Spring and Summer:* about a *seventh part* is usually in a state of *fallow*, and, if kept free from weeds, as a fallow to be useful should be when the outward soil is dry, affords little moisture compared with its former state.

According to Bishop Watson, land, even in this state, gives water to the atmosphere, at the rate of twelve hundred gallons from an acre in twelve hours. The mode he took to ascertain this fact was as follows. He measured the mouth of a drinking glass, which he used in the experiment, and found the area to be twenty square inches; this was put on a close-mown grass plat, after there had been no rain for a month. When the glass had remained inverted on the grass-plat a quarter of an hour, the inside was wiped with a piece of muslin previously weighed; when the glass was wiped dry, the muslin was weighed again, the increase of weight shewing the quantity of collected vapour; the medium between twelve and three o'clock, on a hot day, from twenty square inches of earth, was six grains. Now, as there are twelve hundred and ninety-six square inches in a square yard, and four thousand eight hundred and forty square yards in a statute acre; we find that above sixteen hundred gallons, reckoning eight pints to a gallon, and the weight of a pint one pound avoirdupoise, seven thousand of Troy-weight, would be raised from one acre every twelve hours.—Two other experiments, after the ground had been wetted by a thunder shower the day before, and the heat of the ground by a thermometer laid on the grass, being at ninety-six degrees; one gave, one thousand nine hundred and seventy-three gallons in twelve hours; the other gave one thousand nine hundred and five. But as these experiments were made in the hottest part of the day, from twelve to three, perhaps twelve hundred is about the average of twelve hours; yet, in order to see whether the copious vapour collected by the glass, was owing to the natural perspiration of the grass, or to a kind of mechanical distillation from the body of the earth, I put the glass upon a dry foot-path—the vapour rose from the foot-path as well as from the grass, but not so abundantly. —*Vid. Chem. Essays, vol. 3d. Ess. 2d.*

The inference must be obvious; if the evaporation from the dry close-mown grass-plat was much greater than from the bare foot-path, *how* *much more must it be* from rich pasture lands than from close-mown walks; and how much more still from luxuriant vegetable crops? Besides, the cultivated annuals do not completely cover the ground till towards the end of May, and the earth is then warmed by the uninterrupted rays of heat from the sun, which moderates the nocturnal cold, and thus prevents those sudden checks which vegetation frequently receives in England from irregularity of temperature. But, of late years, the increased population, and attendant luxuries of horses, arboreous plantations, &c. have occasioned a demand for a larger cultivated surface; Agriculture, therefore, has necessarily been improved, and pasturage extended; and as the deep lands in the vales had been tolerably cultivated by the efforts of our Ancestors, we possessed no alternative in our wish to meet such increasing demands but that of exercising our skill and industry on lands of inferior quality; such as shallow soils, wastes, or high mountainous tracts, where the scanty shrubs and bramble herbage have been torn up by the plough, and the depth of soil increased by an intermixture of marl, lime, and other manures. When such lands are brought into cultivation, intersected by high quick fences, and become productive of luxuriant crops, they generate a more vapourous atmosphere; and consequently the climate undergoes a change; it actually begins to revert, or go back again, especially in the spring and summer, when such causes are most in action; but at the time of harvest, when the crops are removed, the soil presents a surface to the Sun, almost as little shaded as a field under summer fallow; and when the outward soil is dry, these stubbles contribute evidently, by the dry heated air, which we see undulating over them in the Day, to clear the Atmosphere, and tend, in some degree, to brighten the Sky. Accordingly, we generally find, that our Autumns are very fine, and frequently the hottest and driest part of the Year; for the heat the soil thus receives, is gradually, and, as it were, reluctantly given back to the Atmosphere; so that it moderates the cold of the ensuing Winter, which is the reason that, of late years, our Springs and Summers are on the average colder, and our Winters milder, than they were forty years ago*. These phenomena of milder Winters, will, in the sequel, be further noticed. By referring to my meteorological journal for the last summer, 1805, I find the following remark, on the 6th of June:—" The crops of grass, corn, pulse, and every article of vegetable produce being so remarkably luxuriant in leaf and stem, and the earth very moist, there is little chance of settled weather till after harvest, unless we should have dry continental winds, from an easterly or north-easterly point, to absorb some of the daily exhaled vapour." The event fully accorded with the prediction on my journal; for there were about seven dry cloudy days, with gentle easterly winds the beginning of July, which fortunately happened during the time the Wheat was in bloom, in Worcestershire, and Herefordshire. The remaining part of the Summer was one continued scene of unsettled weather; if the Sun broke out occasionally for an hour or two together, it was soon obscured with clouds, causing frequent thunder-showers, or a dense vapourous atmosphere.

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* It has been a general remark, by persons observant of cause and effect, that a dry and warm Autumn is almost invariably followed by a comparatively mild winter. To those who dislike long recollections, these two seasons, in the years 1804 and 1805, just past, may suffice.

In Worcester there was not, according to my observations, a single bright day, entirely devoid of cloud, from the 12th of April till the 14th of September. Some seasons, when the hay harvest is early*, the removal of an immense exhaling surface of grass has an influence on the weather, particularly if a few bright days immediately succeed, as a check is then given to the latter-math; and, during this interval, between the *hay* and *corn*-harvest, we have fine weather for filling and ripening the grain. The produce, in such cases, is generally abundant; but this was not the case last summer; the showery weather retarded the hay-making; so that no interval occurred between the *Hay* and *Corn* harvest. About the 21st of August, the corn began universally to turn colour, the exhalation gradually ceased, and when the conducting surface was removed by housing the crops, the accidental showers we had before experienced, became much less frequent; the crop was mostly got in well; all might have been secured in high perfection; but many farmers were too hasty in clearing their fields, being fearful of the weather.

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* And here it may be proper to suggest, that not only on this account is it advisable, but as economy in the farmer to never *haine up late*; perhaps policy, both with respect to land and cattle, would, if the winter be mild, forbid sending the cattle to field *after Candlemas*. The injury arising from treading the land is incalculable; the future scanty crop, and the breaking in upon the most interesting time,

The Barley in Worcestershire was much injured from this circumstance; for its damp state occasioned it to heat in the mow. Under this impression, it is generally considered that barley, when advanced into that state called the *red*

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in a farmer's calendar, the harvest, he will perhaps be able to appreciate. Fastening the gates of pasture land early, is a sure game; that of neglecting or overlooking it, hazardous in the extreme.

row, that is, when the seeds assume a *crimson colour in the lines*, which run down their outward surface, it is fit to cut; even while the stem is green: not considering that, as a highly saccharine plant, its juices ought to be more matured on the plant than most farinaceous vegetables. Practical Agriculturists should impress this truth on their memories, that, after a showery Summer, the chances are five, if not six, to one in favour of a dry harvest, on account of the enormous exhaling surface which is removed at that time. *This theory will*, if closely observed, be found to agree with our experience in this Country, as I have remarked for many years past.

England does not suffer from a *wet harvest* above once in six or seven years; and when even this happens, it arises from some *general cause*, not from *local influence*, and then our Continental neighbours experience the calamity partially, if not equally with ourselves; the last season of this kind was in the year 1799; the Spring commenced in April, with frequent storms of snow; May and June were remarkably cool and cloudy; July and August, even cold and wet; the grain turned colour, the weather seemed labouring to clear for the first eleven days in September, when the rain again commenced, and so continued till the winter frosts set in, which were very severe; for, on the 30th and 31st of

December, the thermometer was as low as ten degrees. The process of vegetation was so much retarded, that the leaves of the Elm, in Worcestershire, did not fall till the middle of December, and many oaks even retained their foliage till the commencement of the severe frosts, at the close of the month; the leaves at last *seemed* to have fallen in consequence of the *frost*, and not owing to nature having effected her purpose; as the buds in the axilla of each leaf were very small, and not full and prominent, as is usual after warmer and more genial Seasons. The first shoots also of these trees appeared exceedingly weak in the following spring; the grain was very deficient in *quantity*, and the *quality* was still worse; so that if it had not been for the exertions of Government promoting the import of grain, rice, and other provisions, the Country must have experienced the horrors of Famine; as the succeeding harvest of 1800 was unproductive; owing to a deficiency of stock plants, occasioned by the bad seed time in the previous Autumn: and, as we have before observed, to a practice scandalously common, *imperfect seed being committed to the ground.*

If so unfavourable a season as that of 1799 should again happen, would it not be prudent to sow *two-years old wheat*, rather than such as is imperfect, and liable to be unproductive? Two-years old seed is frequently made use of in some parts of Gloucestershire with great success; and we find many vegetables more prolific when raised from seed of more than one year old, as Cabbage, Brocoli, Melons, &c; and it has been observed by experienced men, that *Rape* and *Turnip* seed, in such cases, is not so liable to suffer by the fly; but as such plants vegetate with less luxuriance, the practice might not be so eligible *on poor soils*; although there is reason to conclude, that wheat raised from two years-old seed, on *highly-manured lands*, would in general yield more: its deficiency in luxuriance would favour its escape from mildew, and it would exhale less; so that the ground, not being so much deprived of its moisture, nor the Atmosphere so much polluted by its exhalation, a greater number of plants per acre would be enabled to perfect their fructification, and the grain would, *cæteris paribus*, ripen earlier. If it be objected, that it would require more seed to be sown, as it will not *tiller*, as it is termed, so much as more luxuriant plants. We answer, *such observations should be accurately proved by unexceptionable experiments.* England, from its insular situation, as we have observed before, is naturally more disposed to humidity than countries on the Continent, as all lateral currents of air, except those, which proceed from an easterly or north-easterly point, bring with them an Atmosphere loaded with aqueous particles. We ought, therefore, to be particularly cautious how we increase this disposition by an *injudicious* cultivation of the soil; for, upon an impartial enquiry it will be found that we very rarely, if ever, suffer from great droughts, such as are sometimes experienced in Spain or Portugal.

That this country has been often on the verge of Famine, is evident from history, owing to a failure of our crops, but then it will be found to have arisen from a deficiency, not from a superfluity of solar influence. I grant, should we attend to the idle murmurs of some practical agriculturists, the weather is never right—it is either too hot or too cold, too wet or too dry. If an English farmer observes his grass a little brown, he instantly complains, without reflecting, that every blade which has vegetated under a warm Sun, contains a much larger proportion of nutriment, than that which has been raised in clouded and rainy weather. I will ask a practical grazier this question—Do not your beasts look *washy* and *thin* after a continuance of wet weather; and when slaughtered in the Autumn, do they die so fat, or weigh so well? It was an observation of a very respectable landed proprietor in the County of Worcester, and who lately died at a very advanced age, in answer to occasional complaints of drought, preferred by his tenants: "Never fear; I have often known England suffer from too much cold and wet, but never from too much heat." That the country sometimes has suffered a temporary inconvenience from drought, I am willing to allow, but never to such a degree as to occasion a scarcity of animal or vegetable produce; butter, during such temporary drought, sometimes advances in price, but this is not a necessary of life, and we can willingly submit to the inconvenience if the bread we are to eat with it is but cheap.

It is further true, some lands, whose substratum consists of a keen gravel, or other silicious earths, can bear but little sun, and be productive, owing to their impatience in retaining moisture, and as generally possessing a very shallow stratum of carbonic vegetable mould. Lands of this description we frequently find to be most improperly managed; for if they are situated near to towns, they are, in the present rage for pasturage, generally laid down with perennial grasses, though perhaps the upper stratum of vegetable mould does not exceed three or four inches in depth. Such land, so cultivated, must burn in summer whenever the weather is favourable to the greater part of the country. This kind of soil was called by our ancestors *rye-land*; and this species of grain, with barley, was the principal produce of land so denominated. These soils are commonly not ploughed sufficiently deep; in general the plough does not penetrate more than four inches. This shallow upper stratum, by the frequent ploughing in of stubbles, and, with the use of lime and other manure, becomes a fine mould, which keeps the radical fibres of the plants too near the surface; so that if there happen ten or twelve days of dry weather in summer, the moisture becomes nearly exhausted, and the crops burn up or dwindle away. Such land should be ploughed much deeper than it usually is; for although a portion of gravel will, by this means, be brought upon the surface, yet it will prove advantageous; as the carbonic vegetable mould will, by the same means, be placed at a lower depth, and induce the radical fibres to penetrate deeper in search of nutriment and moisture.

When a gardener hires a piece of ground of this description, he immediately trenches it to the depth of from *sixteen* to *twenty-four* inches, and finds his vegetables to endure a dry season so much the better. In this kind of land, barley should always be sown *early*, perhaps never later than the 20th of March; for although it may turn yellow, if cold rain, sleet, or snow happen in April or May; yet with the first returning warmth, it will recover its healthy complexion: the great danger of sowing early in this kind of land is, the fear of weeds; but this evil is more in idea than reality, and, if the grain is sowed thick, this inconvenience is generally avoided. The seed, too, should always be soaked either in water, or, what is much better, the exudation from a dung heap, for forty-eight hours previously to its being committed to the ground; a precaution that will insure its *simultaneous germination*, and consequently its ripening at the same time, which is an advantage of no small importance to the prosperity of the crop; for it may almost invariably be concluded, that if barley comes up *even*, that is *regular*, a good crop may be depended upon; but if *uneven*, the reverse.

The subject treated of in this work will doubtless occasion much diversity of opinion, particularly as many modern improvements, now pursued with such enthusiasm, are shewn *indirectly* to have an unfavourable effect on the industry and resources of the country; and when popular prejudices are first opposed, a host of adversaries commonly arise to attack the daring innovation. This has ever been the case with the most valuable information, when offered to the consideration of the many; it was the case with respect to the introduction of inoculation for the small-pox, and the recent attempt of Dr. Jenner for its extirpation by vaccination: with many other useful discoveries. The advancement of knowledge is certainly promoted by this circumstance; the reluctance which men shew to adopt new opinions till they have borne the test of experience, is certainly very laudable and proper; for if Society were to adopt as truths the suggestions of every physical enquirer, knowledge would become retrograde, instead of gradually advancing towards perfection. The Author sincerely hopes that those who may be disposed to doubt the truth of his Theory, will suspend their judgment, till a candid enquiry may have been instituted for its investigation. Whatever opposition the doctrine may meet with at first, he has little doubt but at some future period, when the prejudices of men are removed, that the good sense of the English nation (the first to apply and adopt useful discoveries) will induce them strenuously to devote their attention to a subject, which offers such a field of useful enquiry; and which promises, when attended to, an extension of national wealth, prosperity, and independence.

The question respecting the local influence of aqueous and vegetable surface on the Atmosphere of a country, cannot be decided by mere *argumentation*; but future experience will shew whether, or not the suggestions here adduced are founded on fact. The evil is already great, and alarmingly increasing; more land is still annually laid down for pasturage; the fences and trees, planted in the more recent inclosures, are yet in their infancy; the soil is not yet in a sufficient state of tilth to yield very luxuriant crops; all the canals and wet docks, now making, are not yet filled with water; nor have the latest plantations assumed the appearance of *forests.* Unless the annual fall of timber should overbalance, by a reduction of vegetable surface, these various sources of aqueous exhalation, (which, if practicable, appears unlikely to happen) we may expect our Springs and Summers to be still more unfavourable to vegetation than they at present are; *spring frosts, blue mists,* and *blights,* will become a more just cause of general and frequent complaint; and, in Summer, we shall oftener have occasion to lament the effects of cold wet weather; mildews and rust in the inclosed vale countries; late harvests in general, and disappointments in the produce both of corn and fruits. From the middle of April till the removal of the corn at harvest, we must, on the average of our seasons, expect the weather to be very unsettled and unseasonable; in the earlier part of this period, we shall have more frequent frosts, with chilling rains; and, in the latter part, more thunder storms, accompanied by a close humid vapourous Atmosphere. All the changes hitherto made in agriculture have produced an *accidental effect* on the Atmosphere. Nothing has yet been done with a *direct* view of improving the Climate; indeed it is much to be lamented that the greater number of what are called vast improvements, have, for the last thirty years, had an unfavourable influence on the Seasons; the widening of turnpike roads, and draining of morasses and fens, are the only modern improvements which have a real tendency to produce warm salutary weather in Spring and Summer. But these are completely counteracted by inclosures and canals; the latter, perhaps, present an aqueous surface to the Sun and Air of greater extent than all the swamps and morasses that ever existed in the most rude and uncultivated state of the Island. Much has been said on the advantage of inclosures, in promoting warmth and shelter, and, with regard to Pasturage, they may perhaps be advantageous for screening cattle from strong currents of air, and producing earlier crops; but if the quantity of vapour exhaled from these fences, is greater than it would be from the same space of cropped ground devoid of them, it is indirectly disadvantageous to the production of early crops; as it occasions more cloud, and consequently thickens the *screen*, or medium between the surface and the Sun, and thus retards the progress of vegetation. High fences are undoubtedly injurious to *Corn lands*, particularly if the inclosures are small; or, in the latter stages of the growth of wheat, and during its filling and ripening, if the weather is humid, the fences prevent the proper ventilation, and consequently favour the *rust* and *mildew*.

I particularly remarked the progress of the *mildew* on the wheat in Worcestershire, in the last season, 1805; it did not appear in the neighbourhood, where my observations were made, till the first week in August, and then principally in the smaller inclosures; particularly where there were many trees in the hedge-rows. The larger fields, which lay well for ventilation, escaped altogether, except in those parts of the field where the grain was beaten down by the rain. The variety, called *Lammas*, suffered most; the *cone* wheat, having a larger surface exposed to air, from the circumstance of its growing higher, its not being so liable to be beaten down, and, from its ear, possessing an awn, or beard, which extends the perspiring surface; was enabled to escape the inconvenience suffered by the other. Accordingly, as might have been expected, the *cone* wheat yielded better than the *Lammas*; of several fields of the latter, which suffered from mildew, I took an opportunity of enquiring the yielding result, and found it amounted to only eighteen bushels per acre, *(being only nine for one)* and the grains were many of them light and shrivelled. In consequence of these partial failures, the crop, taking the County together, fell much below the usual average produce; which occasioned the price to be advanced higher than in those Counties where the inclosures were larger, and the grain yielded better, as in Norfolk and the more open parts of Oxford, Berks, and Wilts. The mildew was not so universal this Year, 1805, as it is in some Seasons, owing to the rains coming in storms, attended with southerly or westerly winds, which, drying the leaves and stalks once or twice in the course of the day, much retarded the progress of this disease. It may be observed, too, that the mildew is always worse when the rains in July and the beginning of August, are attended with a *close calm atmosphere.* In addition to the disease of mildew, which lofty fences occasion in small inclosures, and thus deprive the Country, five seasons out of seven, of many thousand quarters of grain, they produce another inconvenience, *that of exhausting the soil of its moisture, whenever a drought sets in, owing to the quantity absorbed by the roots of such fences.* Evaporation, even in our wet summers, is greater than the deposition of water by rains; and as the vegetable surface of the Island is now so vastly extended, the land, in dry weather, is rapidly exhausted of its moisture; so that generally in Autumn we find a universal complaint of the lowness of our ponds, and the failure in our springs. Many who may not have the means or the inclination to examine the matter on an extensive scale, in our fields and plantations, may ascertain the fact, by observing how quickly some Species of Geraniums, Asters, and other plants in the Green-house, part with their water, and the almost daily supply necessary to preserve them in a state of health. *Quære*—Might it not be advisable to meet this difficulty, which in many countries is a very serious evil at this season, to adopt the Eastern mode of wells for watering our cattle, *instead of open ponds?* In the one case, evaporation could be but trifling; in the other, it is immense. One sunk, for this purpose, at the corner of a field, would, where the land was held by one occupant, or where the different occupiers might agree, serve the purposes of four. Even the advocates for inclosing admit this circumstance, and acknowledge that the crops so situated burn first.—*(See Practical Agriculture, by Dr. Dickson, page* 108, *and Middleton's View of the Agriculture of the County of Middlesex.)*

If shelter from winds were so absolutely necessary as some people suppose, how is it, that the farmers in Norfolk commonly obtain such enviable crops? The inclosures there are so large, that the middle of the fields cannot be much benefited by their shelter; and that County is fully exposed to the *Siberian winds*, which so frequently visit us in the spring of the year. However, it must be allowed, if fences are properly managed, and judicious vegetables are selected for making them, that they are, or rather may be made, advantageous to the Agriculture of this Country; for these boundaries render each farmer independant of his neighbour, and save much labour in attending cattle, which would otherwise be lost. When men begin to be convinced of the propriety of attending to the local influence of vegetable and aqueous surface on our Climate, and reflect well on its productions, it will form a *new Æra* in the annals of Agriculture; and till this desirable event shall take place, the following suggestions are candidly offered to those, who may be disposed to apply their skill, industry, and resources to this *great undertaking:—First, a judicious selection of vegetables for forming fences; secondly, a more economical method of feeding horses, so as to lessen the demand for hay, and, by this means, reduce the proportion of pasturage; and, thirdly, to use greater* *precaution in the choice of trees, and methods of making arboreous plantations; and, finally, to remove all unnecessary exhaling surface, such as old pollard trees, stools of alder, or willow, and weeds in the banks of hedges; which are allowed to pollute the atmosphere for no useful purpose whatever.*

CHAPTER XI.

Attention to Fences—A reduction of them, and planting such Vegetables for the Purpose as evaporate little—France and other Countries probably owe much of their serene Atmosphere to this, among many other Causes, &c.

No fences should, on any account, be permitted to grow higher than about four feet and a half, except such as surround our gardens or plantations; and then only for the purpose of breaking the force of the winds, or for the security of our property. By reducing the height and breadth of the fences in the open country, we shall avoid many disadvantages. We often do great injury to our gardens by fences and plantations, made with a view of warmth and shelter; for, when we have much sun, accompanied by little wind, a calm is by this means produced, which increases the heat, and consequently the capacity of the air for moisture; as is very visible by a Hygrometer, kept in such places. In the beginning of May, (this year 1806) the Acari miserably infested the Gooseberry trees in gardens thus shut up and exposed to moisture; while those exposed to greater ventilation, escaped this evil; so that it is evident that high fences and trees tend, under different circumstances, to produce atmospheric extremes—aridity, when the air is dry; and humidity, when it is wet and damp. The exhaling surface, exposed to the air, being diminished, less vapour will be given out to the Atmosphere, and that arising from our luxuriant crops will not, in windy weather, be so much deprived of its Electricity, by passing through the interstices of the tall fences. The *hawthorn shrub*, Crategus oxyacantha, is the vegetable most commonly used for forming fences in England; this shrub protrudes its vernal foliage very early in the Season; the leaves frequently are fully expanded as early as the first week in April; and most commonly so before the end of the month. This early protrusion of its vernal foliage, happening at a time when the Sun's elevation is insufficient to heat the Atmosphere to any considerable degree, is very injurious, as it contributes, with the highly-manured pastures, to generate a vapourous Atmosphere, which becomes condensed or congealed by the cold air in the regions over our heads; and which, in storms, returns to the Earth in the state of snow, hail or sleet, or cold rains. These accidental, chilling storms, which happen so frequently in April and May, are so far from contributing to the health and vigour of vegetation, that they produce an opposite effect; turning the grain yellow, checking the growth of grass, cutting off our fruits, and disappointing our growing hopes. By considering snow, hail, and cold rains as injurious, the Author does not mean to include *all irrigation;* the rains, accompanied with warmth from a southerly or westerly point, are in fact every thing, that we can wish for at this season for promoting fertility; *such are big with life*, and never turn our grain yellow, or destroy our fruit; but give additional health and vigour; these rains are not caused by the vapours of our own Island, but are evidently brought in from the Sea, and generally preceded by a fall of the Barometer. These fences also, if the Month of May is wet, yield sustenance to a host of Caterpillars, which turn to Butterflies, lay their eggs, and their larva come out again in the Autumn to commit greater depredations on our winter crops of tetradynameous vegetables, as Turnips, Rape, Savoys, and numerous others, useful to man and beast. The breed of sparrows, and other small birds, is likewise much encouraged by these fences; the quantity of Grain annually destroyed by these winged miscreants, in the vale counties, is enormous; parochial officers were formerly used to bid a reward for the destruction of sparrows; but of late they have been allowed to increase so much as to become a serious nuisance: it has been thought by some persons that the breed of these birds should be encouraged for this reason, that they destroy so many Insects, and thus render to us ample service for the small quantity of grain they may at other times eat. That they destroy vast numbers of caterpillars is certain; as, in the Spring of the year, we observe them very active in picking up and eating the Insects from the curled leaves of the apple; but the supply from the hawthorn fences, in a wet Spring, is so abundant, that the quantity devouredby sparrows is of no avail: the first foliage of the apple being still materially injured every Season. That it would be sound policy to lessen the number of sparrows there cannot be a doubt, as we should annually save many thousand bushels of grain from these wily depredators; yet *an entire extirpation* would perhaps be wrong; as they were doubtless created for some useful purpose: humanity in excess may defeat the kind intentions of the Creator.

The hawthorn makes an admirable fence, were it not for the reasons assigned, and if these were not formidable, perhaps it would be as desirable a shrub for forming fences as any we possess. Amongst the various indigenous vegetables found in this Island. None perhaps holds out so many advantages for forming a secure and truly valuable fence as the Ilex aquifolium, common holly; it is a hardy tree, enduring equally the heat of Summer and cold of Winter, and will grow in almost every situation, except fen or morass: it is an evergreen, and therefore well calculated for sheltering cattle in severe weather. Notwithstanding it retains its leaves throughout the Year, it scarcely exhales at all in Winter; so that we need not fear its exhalation contributing to form cloud at this Season; its vernal foliage is not protruded till late in the Spring, the new leaves rarely beginning to appear till towards the end of May, and are seldom fully expanded till the middle of June*. The proportionate exhalation of the hawthorn and the holly are as nine to one. Supposing, then, both fences to expose the same quantity of surface to the Sun and air, the hawthorn would, in Spring and Summer, exhale nine times as much as the holly; so that the universal substitution of this last vegetable for a fence would be adequate to the annihilation of *nine parts out of ten* of all the fences in England. It is armed with prickles, particularly if kept low as a shrub. (*Phytologia, p.* 35); but the leaves cease to be armed with this defence if allowed to grow up as a tree; so that nature seems to have given it this peculiar organization, to enable it to protect itself from the depredations of cattle, which gives it a decided preference, as a fence, to numerous others, *apparently as eligible.* Another circumstance, too, should not be left unnoticed; which is, that it affords nutriment to sheep and cattle if cropped in severe winters, when other fodder is scarce.—(*Pennant's Tour*, 1778, *p.* 32.) Every farm possessing fences of this description, would therefore have a constant succedaneum, in case of a scarcity of fodder; as the fences, when arrived at the requisite height, might occasionally be cropped for such purposes, without any injury; so that the land, now occupied with hedges, would not be wholly lost, as at present is the case. The appearance of this beautiful evergreen to the eye, is some recommendation, particularly in the Winter; when the Sun shines on its finely-polished leaves: it would give a cheerful appearance to the country, at a season of the year when our fields look so dreary, cheerless, and void; that time

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* The newly-expanded leaves on all trees and vegetables, both deciduous and evergreen, exhale most moisture when young; the leaf gradually loses its activity as it becomes older, having then effected its purpose; which is the reason that, in North America, England, and all countries that possess numerous trees or hedges the climate is more settled and dry in the Autumn than in the Spring and Summer. In the northern provinces of China they reckon on experiencing settled weather in Autumn with such certainty, that they do not house their grain, but thrash it in the open fields, previous to the setting in of winter rains.—*Vid. Barrow's Travels.*

> "Dread Winter spreads his latest gloom,
> And reigns tremendous o'er the conquered Year;
> How dead the vegetable Kingdom lies!
> ———————Horror wide extends
> Her desolate domain, cheerless, and void
> Of every life, that from the dreary months
> Flies conscious southward."
>
> THOMSON'S WINTER.

A writer in that excellent work, the Spectator of Addison, makes the following observations: "I find that, in the discourse which I spoke of at the beginning of my letter, you are against filling an English garden with evergreens; and indeed I am so far of your opinion, that I can by no means think the verdure of an evergreen comparable to that which shoots out annually, and clothes our trees in the summer season. But I have often wondered that those, who are like myself, and love to live in gardens, have never thought of contriving a Winter garden which would consist of such trees only as never cast their leaves. We have very often little gleams of sunshine and fair weather in the most uncomfortable parts of the Year, and have frequently several days in November and January that are as agreeable as any in the finest months; at such times, therefore, I think there could not be a greater pleasure than to walk in such a Winter garden as I have proposed. In the Summer season the whole country blooms, and is a kind of garden, for which reason we are not so sensible of those beauties that, at this time, may be every where met with; but when Nature is in her desolation, and presents us with nothing but bleak and barren prospects, there is something unspeakably cheerful in a spot of ground which is covered with trees that smile amidst all the rigour of winter, and give us a view of the most gay season, in the midst of that which is the most dead and melancholy. I have so far indulged myself in this thought that I have set apart a whole acre of ground for the executing of it; the walls are covered with ivy instead of vines; the laurel, the horn-beam, and the holly, with many other trees and plants of the same nature, grow so thick in it, that you cannot imagine a more lively scene; the glowing redness of the berries with which they are hung at this time, vies with the verdure of their leaves, and are apt to inspire the heart of the beholder with that vernal delight, which you have somewhere taken notice of in your former papers. It is very pleasant, at the same time, to see the several kinds of birds retiring into this little green spot, and enjoying themselves among the branches."—*Vid. Spectator, No.* 477. In enumerating the advantages derivable from the use of this vegetable as a fence, it should not be forgotten also, that it does not yield sustenance either to the *Aphis or Caterpillar;* and, as far as my observations have extended, is not liable to be attacked by any kind of destructive Insect. Dr. Darwin remarks, that it affords much provender to the deer and cattle in Needwood forest during severe seasons of frost and snow; and thinks, in times of great scarcity, that an esculent food might be obtained for the use of the human species, by a preparation of the celular substance contained in the inner bark.—(*Phytologia, sec.* 17. 33.)

To those who may be apprehensive that, as it is an evergreen, it might contribute to vaporize the atmosphere in Winter, I would recommend an attention to the great length of time it will continue exposed to the external air at this season without fading, which shews how very tenacious it is of moisture. From experiments, its exhalation appears to be very small at this Season, and the ground, from having been drenched with rain, presents such an evaporating surface, that the addition of our holly fences would be too inconsiderable to take into the account. The greatest objection to the use of it, as a fence, is *the slowness of its growth in its early state;* but if the plants are six inches high, when planted, they may, by proper attention, be raised to the height of four or five feet in ten years; when they have taken root, they will grow from six to nine inches in one Summer, and sometimesmore. The best time of the Year for planting this vegetable, is at the end of April, or beginning of May; if the plants are removed earlier, or in the end of Autumn, the greater part of them will die, as I found by experience three Years ago, when I lined a garden hedge with plants of this description; but the plants with which I filled up the vacancies, at the *end of April*, all succeeded. Various experiments should be made to discover the best and most expeditious way of propagating *holly*; it will grow from layers, and it should be tried from cuttings, planted at the end of April, or beginning of May, in a shaded situation: the seed, like the hawthorn, does not vegetate till the second year.

The influence of hawthorn fences on the Climate in this country in the Spring, may, to many persons, appear trifling, and be thought too inconsiderable to have any material effect on the atmosphere; but I am persuaded that every reflecting mind will be convinced they must produce a considerable influence. Suppose all the fences in England to be collected into one forest of underwood, what an inconceivable extent of surface they would cover; then imagine such a forest in full foliage the first week in May, as is commonly the case—what a quantity of vapour must arise from these new, and numerous leaves. But if we would properly judge of the effects, we must make a comparison with our native forests at this Season; such as the new forest, Hants; that of Dean, in Gloucestershire; or Needwood, in Nottinghamshire; here we shall find the vernal foliage of our indigenous trees; as the oak, beech, ash, and pine, all silent and wrapt up in their winter buds; as if aware, by fatal experience, of the treachery of the Climate, they are cautious of exposing their viviparous progeny to the casualties of this early part of the Season*.

There is great reason to think, that, notwithstanding the Climate of France is so much extolled, if the northern parts were divided by quick fences with trees in the hedge-rows, and the same proportion of pasturage; *their* atmosphere would be as clouded and unsettled in the early part of the summer, *as ours*. Persons who have resided at Douay, Valenciennes, and other places within one hundred miles of the coast, describe the Climate as settled during Spring and Summer, and the sky frequently without a cloud for several weeks together, and that the corn is abundant, although the land has much less artificial aid from manures than lands in England; yet the neighbourhood of some of these towns is as near the coast as many situations in the central Counties of England, and, with a westerly wind, they must be as liable to a vapourous atmosphere from the English channel and Atlantic Ocean as we are.

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* Seeds are the oviparous progeny of vegetables; buds the viviparous.—*Vid. Phytologia.*

Respecting the effects of a cold vapourous atmosphere, I received this desirable intelligence from a French emigrant Priest, who resided, previously to the passing of the decree against the Clergy, at Rouen, in Normandy. In answer to my enquiries respecting the weather, blights, &c. in that country, he informed me the east wind was always, in the Spring, attended with a bright clear sky; and that if this wind happened during the bloom of the apple trees, they had an abundant crop of fruit; but if a wind from the *north-west* happened, during this period, it invariably occasioned a blight, which was always attended with a vapourous atmosphere; and never failed, if it continued but a few days, effectually to destroy every hope respecting the future crop. I thought this circumstance, so strongly connected with my view of the effects produced by our vapourous atmosphere, that I did not feel satisfied at first as to its accuracy. I questioned this Gentleman further, lest he might have forgotten the point of the compass, and that it might be a *north* or *north-east* wind, which occasioned this injury to the fruit trees, and I received for answer, that " these winds were cold in Normandy, but did not produce the blight: *and that it was the execrable English wind that did all the injury, which came across the channel to Rouen, from the Isle of Wight.*

By examining an accurate chart, we shall find this stream of air must pass over all the western half of our Islands; and the vapourous atmosphere, raised from our highly-manured pastures, hedges, and other vernal crops, is thus wafted to our neighbours, and produces the same lamentable effects on their fruit trees as we so commonly experience in our own. According to Dr. Smollett, who resided about forty years ago in France, the mode of intersecting their cultivated fields with hedges, after the *English fashion*, was beginning in some places to be adopted; but it does not appear, from the publications of more recent travellers, that this fencing system has made any considerable progress. Mr. Holcroft, in his Tour from Hamburgh through Holland and the Netherlands to Paris, notices still the *Harlequin appearance of landscape*, in a French cultivated country, where he tells us there are no hedges; so that vast crops meet the eye without any division, except the chequered variation of colours. Here various compartments of crimson saint-foin, blue flax, yellow radish, green barley, and the brown vineyard, form a ludicrous Salmagundi. The land, he observes, lost in hedges and ditches in England, is immense; but the labour saved in watching cattle, is probably more than equivalent; the ditches serve as drains, and the hedges help to increase the supply of fuel. To the last observation might, with propriety, have been added; but alas! what a vapourous veil do these hedges contribute to form; and thus, in part, to deprive the Country of two of its greatest blessings—*light and warmth!*—If France and the surrounding Countries were cultivated to the extent of surface, and, in the same way, divided by fences and trees as England, there is great reason to believe that, notwithstanding their continental situation, their fruit seasons would become as precarious as ours.

CHAPTER XII.

Extent of Pasturage from the increasing Advance of Labour—High Taxes—And the Influence of Tythes, &c.

IN addition to the great demand for hay to supply food for our horses, other circumstances likewise tend to encourage pasturage, and reduce tillage. Taxes, labour, and tythes, all (but particularly tythes) bear much heavier on the products of arable than on grazing land, and consequently operate as a bounty upon pasturage; the increased prices of all the necessaries of life, the result of extraordinary Taxation, gave rise to the evil, The late American revolution was the cause of its commencement, and the dreadful struggle in which England has since been involved, in consequence of the unparalleled, and I may say, unexampled events which have followed the French revolution, have increased it. Taking the average of the last seven years, we find, that the necessaries of life are double what they were thirty years ago; consequently the Clergy, and Lay proprietors of tythes, have been obliged to raise their decimal rents, to enable their respective incomes to meet the advanced price of provisions and increased expenditure. But, in justice to the *Clergy*, it must be acknowledged, that they do not exact so rigorously what is justly due to them, as the *lay proprietors*; and in many parishes a very considerable portion of the land is annually laid down and turned into permanent pasturage, because the occupier can make a better bargain with the Clergyman than with the Squire; should he be possessed of the arable or Great tythes. Grass being a spontaneous crop, and requiring less art and industry to raise it than grain, in a measure occasions this unequal pressure of tythes; as, in one case, a tenth of the produce is taken, and, in the other, a tenth, not only of produce but likewise of the capital and industry employed: and, if the very high price of grain for the last seven years had not tempted many still to hold the plough, a much larger portion of land would have been laid down to grass than already has been. Should any person propose a fair and equitable scheme for redeeming tythes, and for satisfying those entitled to them, so as to raise a secure income, which might keep pace with the future advances on produce, and realize the plan; he would do more for our agricultural improvement than has been effected by all the encouragements for a century past. All who are well disposed to the constitution in Church and State, cannot wish to injure the established Clergy; the income of the greater part, being barely adequate to procure the necessaries of life; and far from sufficient to maintain them in the respectable station they ought to hold in Society. The combination of circumstances which has reduced the proportion of tillage to that of pasturage, is already a very serious evil, and, if not remedied, will eventually become a national calamity; as a portion of the wealth of the Country has annually been conveyed, for the last thirty years, to Foreign Nations, to purchase a necessary supply of grain. The import of grain, oatmeal, and flour, into Great Britain, from 1789 to 1793, including five years, amounted to £.5,066,847; in the year 1793, the nation paid the enormous sum of £.1,410,323 for grain, oatmeal, and flour imported; in the same year, that is from the 5th of January, 1793, to 5th of January, 1794, there was exported (I conclude for the use of our Colonies and Garrisons) grain, wheat, and flour £.79,772 7*s*. 1*d*.

Imported	£.1,410,323
	79,772
	£.1,330,551

Great Britain, therefore, paid to Foreign nations, in the year 1793, for grain and flour, *one million three hundred and thirty thousand five hundred and fifty-one pounds, in addition to the quantity raised in the Island for supporting the Population.* That Year, notwithstanding this great importation, the Country experienced a great scarcity of bread corn, after the harvest of 1795, in consequence of the unusual cold winter of 1794, and the cold spring which preceded this harvest; the average of thirty-two parishes in Cornwall and Devon, yielded only thirteen bushels, and $\frac{9}{16}$ of wheat per acre, and, taking off two bushels for seed, made the acre of land only to yield $5\frac{1}{4}$ for one.—*Vid. Sir John Call, Bart. in Young's Annals of Agriculture.* To remedy this increasing deficiency, and furnish food for an increased Population, a great quantity of waste land has been inclosed and cultivated; perhaps it might have been better, in a national point of view, as well as for the Climate, if these lands had remained as common fields; they must then have continued principally in an *arable state.* The Author of Phytologia has made some very judicious remarks on the comparative advantages of pasturage and tillage; he says, " As pasturage requires fewer hands in the management of it, and less art and attention to conduct it than agriculture; and as its products in flesh, butter, and cheese, take a higher comparative price at market, and are articles of greater luxury than the products of arable land in corn; we may conclude that pasturage will prevail, in all inclosed provinces, over agriculture. And as perhaps tenfold the number of mankind can be supported by the corn produced on an hundred acres of land, than on the animal food which can be raised from it, it follows that an inclosed province will afford sustenance to a much smaller Population; and as the number of inhabitants of a country depends on the ease with which parents can procure sustenance for their families, marriages will become fewer, and the people decrease, when an arable country is converted into pasturage. One very important consequence of any Country producing a greater quantity of corn than it consumes, and thence exporting it to foreign nations, even by means of a bounty, consists in its certainty of preventing famine, the most dreadful of human calamities: as, in years of scarcity, the stream of exportation can be stopped, and produce an ample supply by its stagnation at home. Hence, when a great part of any tract of Country becomes employed in pasturage, instead of agriculture, the Inhabitants will become consumers of flesh instead of consumers of grain; and will consequently decrease in number from the want of sufficient sustenance: besides, persons employed in agriculture are more active and robust than the people of pasturage, and more ingenious in the invention of machines necessary for the more artful cultivation of the soil, as well as more numerous; they will consequently become superior to them in arms and arts, and may, in process of time, conquer them. In many villages where much arable lands have been lately inclosed, the numbers of labouring people have quickly been much diminished, both by the scarcity of food, and want of employment."—*Phytologia.*

> " Worse fares the land, to hast'ning ills a prey,
> " Where wealth accumulates, but men decay;
> " Princes, or Lords, may flourish, or may fade,
> " A breath can make them, as a breath has made,
> " But a bold peasantry, their country's sword,
> " When once destroy'd can never be restor'd."
>
> *Goldsmith's Deserted Village, altered by Darwin.*

At present, however, we need not have any apprehensions of the population thus rapidly declining; the results of the late parliamentary census, for numbering the people, having satisfactorily proved that our Population is increasing; but there is reason to suppose this increase is caused by the prosperity of our manufactures and commerce, more than from an extension of agriculture; men are able to obtain higher wages in manufactories than when employed in husbandry, consequently this enables them to marry and support families. But in the close confined manufactories in large towns, they are not so healthy, and many more children die than otherwise would do if bred in the country; and, if they are reared, are never so strong as those occupied in the labours of the field; succeeding generations will become more puny. and the vigour of our defensive force consequently become diminished. I need not ask a military man from which class of Society he prefers taking a soldier—whether an athletic country peasant, carrying in his countenance the look of health. or the pale-faced artisan, who has been bred up in the midst of a crowded City? The question admits not of two opinions, the preference being universally given to the former. Every means, therefore, should be adopted that has a tendency to discourage pasturage, and to increase the important system of tillage. We shall then extend our National resources, both of wealth and men, and render ourselves less dependent on foreign Nations; a temporary check to our commerce will not be so sensibly felt as it now is; and when we are arrived at a state in which the Country produces a redundancy of wheat, the inferior productions of our fields, such as barley, oats, beans, pease, &c. may be advantageously mixed with chopped straw more generally than is at present practised; and afford a more profitable winter food than hay, for stalled and other beasts. The advantages in the Climate will be great, by its occasioning less local influence on the weather, and thus rendering our seasons warmer and earlier than they now are; this will enable the land to yield more productive crops, empower the farmer to sell his grain with equal profit at a reduced price; to procure labourers for lower wages; and relieve the consumers from the injurious effects of those sudden fluctuations, which of late have so much encouraged a spirit of monopoly, and produced a system of speculation, which, if pursued, it is to be feared, at some future day, will render us not, what our envious neighbours call us, "*a Nation of shopkeepers,*" but *a Nation of gamblers!!!*

If ever England should become a prey to the restless and ambitious projects of her enemies, it will be in consequence of disaffection at home; for so long, say politicians, as Britain is true to herself, she may boldly defy all the efforts of her enemies: and to preserve unanimity among all ranks, the wants of no class in community must be left unattended to. The continuance of that moderation in the executive Government which has subsisted since the accession of the House of Brunswick, will insure the Sovereign the best affections of his subjects, so long as the labouring classes can procure a supply of food and other necessaries by the earnings of their industry.

The system of enquiry on the plan adopted by Arthur Young, Esq. in his Annals of Agriculture, and which has, beyond a doubt, been of essential service to this country, should be further extended; a greater number of foreign correspondencies should be entered into, and particular enquiries made to ascertain the modes in which horses and other cattle are fed in Spain, Portugal, and other Countries, where, from the nature of the Climate, there can be little surplus of grass to make hay for winter stock; and fair experiments should be made at home, by gradually reducing the proportion of hay now used in our stables, and substituting chopped straw and corn, or corn unthreshed with its straw in the state it comes from the mow. The introduction of this mode of feeding horses will effect much towards reducing our grass lands; and the practice should not be hastily condemned, although, *on first trial*, it may appear injurious to the health of the animal. The object to be gained is so vast in its importance on the Climate and products of this Island, that every effort should be made for its general introduction; so as to put a total stop to the use of hay as a winter food for horses. The making of hay to the extent now practised in this country, seems to be a *modern species* of rural economy; for it appears by old accounts of housekeeping some centuries back, that the cattle were killed when fat, generally in the Autumn, and salted down for use in Winter; and in northern Climates they now kill part of their cattle and poultry on the first commencement of the frost, and, by allowing it to freeze, it is preserved from putrifaction; and thus the winter fodder, which these fattened animals would have consumed, is saved. In England formerly, the *loppings* and *croppings* of trees afforded a fodder for the cattle, and were used as a substitute for hay. In the reign of Elizabeth, the inhabitants of *Colton* and *Hawkshead-fells* remonstrated against the number of forges in the country; because they consumed the wood of the ash trees, the croppings of which was the *sole winter food for their cattle.*—(*Pennant's Tour* 1772, *p.* 29.)

As the naturally humid and cloudy Climate of England is increased by inclosures and luxuriant pasture, it may be necessary to say something more on this part of the subject; by way of rendering the cause of such unfavourable influences more familiar to the mind. We will then suppose a given portion of the surface of the Country in a state of *grass*, and another in an arable state. It has already been shewn that the vegetable surface on this Island has its greatest influence on the atmosphere from about the middle of April till the harvest; which varies according to the quantity of solar heat which the crops have experienced during that season; the difference is usually *about three weeks*. If there has been much Sun between the Vernal Equinox and first week in August, the grain in the southern and midland Counties is then ripe; but if the weather during this period has been cloudy and wet, the earth, from the evaporation and absence of the sun's rays, is rendered colder than it otherwise would have been, and the corn does not ripen till *the end of that month, or the beginning of September*.

Hence it must be evident that the Spring and Summer are the Seasons when the local effects of our increased vegetable surface is principally experienced. After the Vernal Equinox, the Sun's altitude being greater, its power every day to dispel the vapour, whether arising from the Land, or brought by winds from the Sea, continually increases; and between this period and the end of April or middle of May, we have usually some clear sunshine, which sets vegetation in motion. The grasses, particularly those which are *perennial*, and those on highly-manured pastures in the vicinity of cities and towns, soon throw out a dense foliage; which, like a forest in miniature, is so closely matted together, that the solar influence is almost entirely prevented from producing its effect on the soil; for the rays of light and heat falling on the leaves, the latter unites with the perspiring matter, and is given back to the atmosphere combined with it in the form of vapour. When the earth is thus covered with a luxuriant surface of grass, there are two impediments to its becoming properly heated; first, from this close covering; and, secondly, from the raised vapour, occasioning cloud, and thus obstructing the sun's rays from falling on it. The temperature of the cold air which descends on us in a calm night in the Spring, is not moderated, as otherwise it would be, owing to the ground not having previously acquired sufficient heat, to give out during the night, to counteract the cold; so that we have often a frost in the end of April or May, as severe as in January.

The frost, which happened on the morning of the 30th of April, 1805, was preceded, in Worcestershire, by a considerable fall of snow the day before, which melted and cooled the ground, eight inches below the surface, to thirty-eight degrees. The wind, on the 29th, proceeded from the N. E.; and, at ten o'clock at night, it became perfectly calm; consequently the frozen stratum over our heads descended by its own gravity, and, meeting with but little heat from the ground, the frost became very intense. The thermometer, at four feet from the ground, at half an hour before sun-rise, stood at 26 degrees below the freezing point. What was the consequence? The early shoots of the vines were mostly cut off, great part of the wall fruit, and even the apples and cherries.

Having, by way of comparison, supposed a given surface of the country in the state of grass, we will now take an equal surface in an arable state; and, supposing it divided, after the accustomed rural economy of the country, into *seven parts*, we should probable have one cropped with wheat, another with barley, oats, pease, clover, or vetches, and one uncropped as *fallow*. It will be obvious to every observant mind acquainted with agriculture, that, in the beginning of Spring, three only of these crops would any way cover the ground, the wheat, clover, and vetches; I say *cover*; for even these do not completely screen the earth from the solar rays till towards the end of May; and the land, cropped with *Lent* grain, *then* presents a considerable unshaded surface to the Sun, and the *fallow*, if free from weeds, receives all the rays without interruption. Taking the whole surface together, therefore, every unprejudiced person must allow, that there is much less vapour raised at this early Season, less cloud formed, and the earth becomes more heated during the Day; and then, like a heated wall, it gives out a part of its acquired and accumulated temperature, and thus moderates the cold of the succeeding Night.

This is not mere theoretic reasoning; I have proved, by actual experiment, that grass land is less heated than arable or less unshaded surface. Having buried tubes of water, at the depth of eight inches beneath the soil, I found, after a continuance of a few bright days, that the water contained in these tubes was more heated under the *uncropped* land; but as the results of these experiments, which were performed some years since, were not committed to paper, I cannot, from memory, accurately state the *exact difference in the temperature.* Persons who may be disposed to doubt the truth of this assertion, I recommend to observe *the appearance of the frost half an hour before sun-rise, both on grass land and arable.* If the preceding day has been bright, they will find much more hoar frost on the grass than on arable, or on less shaded land.

The dryness and consequent warmth of the early part of the summer in England, is greatly influenced by the state of the atmosphere, from the middle of April till the end of the Month of May. If during this period the prevailing weather has been dry, with easterly winds, and a clear bright sky, the vegetable surface is much reduced; that is, the leaves are smaller, shoots shorter, and more slowly protruded; the leaf sooner becomes firm, and acquires a dark green colour, and is not so liable to suffer from frost or Insects; more nutriment is prepared during this state of the air, and the buds in the axilla of each leaf are larger the following Autumn; which favours a disposition to blow the ensuing Spring. During a dry state of the air at this Season, the Lent grain will be found much shorter in the stalk, with fewer leaves, and less annoyed by weeds. When the Sun shines on such surface, the earth, being so little screened, receives the greater part of the rays, and the dryness of the air renders it adequate to absorb the exhaled vapour of the crops, and thus preserve a degree of transparency. But as the Summer comes on, the crops advance in growth, and shade the ground; the oak, fir, pine, and other trees, which open their foliage late, daily increase; the vapour clouds are formed, and, towards evening, we find so great an accumulation of vapour, combined with electric matter, as to occasion a thunder storm, which moistens the ground, and produces more clouds. The earth having been previously warmed by the solar rays, occasions, with the humidity, a most luxuriant vegetation. Although it is much the fashion to condemn easterly winds during this period, yet experience evinces that, on the average of our Seasons, in this northern Climate, such a disposition of the air, *if dry* and *transparent*, will be found best suited to the productions of our Island; for if the prevailing weather in April and May has been humid; the vegetable surface in the fields is greater, and the earth is kept so cool, by the moist evaporating grounds, and consequent unsettled sky, that the leaves of fruit trees are kept tender, and incapable of resisting the slightest frosts, without receiving injury, and the subsequent attacks of infesting Insects.

At the time when England possessed a considerable export trade in corn; for instance, from 1740 to 1760, there was no general complaint in those Counties where the apple and pear were cultivated about the failures of crops. If the trees missed once, there was always a sufficient store of liquor in the cellars, to hold out till the next favourable Season; and every second or third Year, the produce was as much as the farmers could wish, or find casks to contain. But this desirable time is now past; the unfavourable influence experienced in the Vernal season is such as to prohibit us justly to hope for frequent good crops of fruit; the atmosphere is now in general either so disposed to favour blights and Insects, or so cold in the Spring, that, in Herefordshire and Worcestershire, we have been totally or partially deprived of the produce of our apple and pear trees for the last twelve or fifteen years; at least five years out of seven, during this period, if not more: the young, and consequently more vigorous, varieties sometimes escape, but the old ones, partaking more of the debility of age, are utterly unable to withstand these rude and repeated shocks. I have observed before a vaporous atmosphere is particularly unfavourable to the bloom of fruit trees, unless attended with warmth and wind; if the wind is in the South or south-west at this season, we commonly experience a lateral current of air, attended with warmth; this weather is not unfavourable to the bloom of fruit trees, except when rain dilutes the pollen or fructificating powder, and occasions fewer blossoms to set; but if the wind is North, north-east, or East, attended with a gentle lateral current of air, it is always, at this season, accompanied with a *blue haze*, which generally proves fatal to the bloom, either from the cold, disease, or the consequent production of the Aphis. But a moderately brisk wind from these points, although cold in April and May, is not near so unfavourable to the blossom; for we never experience a frost at this season of the Year, without a perfectly calm Night, owing to this wind blowing over the

German Ocean; which affords an air many degrees above the temperature of freezing. The vapour appears to be in a very peculiar state with the slow-moving current of air, which usually attends north-easterly winds in April, May, and June; the atmosphere is usually very dense, yet the vapour is not so disposed to unite into storms as when the wind is north-west; the latter, though stormy, is almost always accompanied with a lower stratum of clear air, and distant objects appear very distinct to the view; whereas, in the former state, the *haze* is such as to render the view of distant objects very imperfect, and at times totally obscure. When the science of Meteorology is further advanced, and the phenomena of the weather better understood, I have not the smallest doubt but art will be able to remove the unsalutary influence of these blue mists, by means of electrical agency; and thus enable Great Britain to vie in some degree, respecting vegetable produce, with more favoured climes. When vegetables are much crowded together, with little ventilation, as we see frequently in hot houses, they rarely, from being thus pent up amidst their own exhalations, escape the plague of the Aphis, the Coccus, or other destructive Insects. But the admission of steam into the interior of the house, attended with warmth, seems, if judiciously managed, to prevent the generation of theſe deſtructive tribes of Inſects. The former ſtate of the hot-houſe may be compared to the effect of the blue miſts of April, May, and June; and the latter, to the warm vaporous ſouth-weſt winds.

CHAPTER XIII.

The removal of useless Vegetables, as Pollard-Trees—Modern ornamental Plantations—Trees in Hedge-Rows—And a general Reduction of Trees recommended.

IN attempting a restoration of our Climate, so as to make it more favourable to the fructification of corn and fruits, and to render the genial time of what is called Spring earlier, and and the weather more settled and salutary; we must endeavour to prevent unnecessary exhalation, by the removal of all useless vegetable productions. In the old inclosed Counties we meet with a vast number of trees, which contribute neither to use nor ornament; these are what are provincially termed pollard-trees, i. e. such as have by accident or design, at some period or other, lost the upper part of their trunks, and are now suffered, with large spreading renovated heads, to pollute the atmosphere for no really useful purpose whatever. The only excuse for allowing them to stand is, that their branches afford *fire-wood*, or materials for repairing defects in fences, &c. &c.; the former use is very uneconomical, and the latter, to say the best of it, shews improvident management of the quick fences, when they can require such kind of repair. Wood fires, it has been justly remarked, impoverish a country.—*(Phytologia, sec.* 10*th*, 11, 4*)*; for the quantity of sublimed soot, when wood is consumed for fuel, is found to be very small indeed, compared with such products from coal fires; and the ashes being always sold to the soap-boiler; there is little or no return of manure made to the farm. It is certainly more for the advantage of an estate that those trees, which are allowed to grow merely for the purpose of fuel, should be removed, as they shade the crops, and materially exhaust the ground. If the croppings of the hedges and elm trees are not sufficient to supply fuel, the expence of fetching a load or two of coal occasionally from the neighbouring town or wharf, will not be found lost labour; as coal yields more soot; and if the ashes are taken care of, and frequently thrown into the privy, it will absorb the materials there deposited, prevent the lavishing waste of a most invaluable manure, and, at the same time, contribute to cleanliness. Experienced agriculturists need not be informed, that this compost is the most valuable yet known for fining and improving grass lands.

It would be an act of policy, therefore, in every landlord, to request of his tenants, that all pollard-trees should be cut down, unless they grow within sight of the farm or mansion-house, and are requisite as ornaments for improving a landscape, or useful to the estate in other respects, from a deficiency of timber. The number of these trees of different species, as oak, ash, elm, and willow, in the old inclosures, are very considerable; in the county of Worcester only, there are, upon a moderate computation, at least three, and *perhaps four hundred thousand trees*, of this description, which might be removed without any sensible injury, either to the proprietor or occupier of the soil: nay, on the contrary, would improve the estates on which they grow, as well as conduce to the amelioration of the Climate. Pollard willows, too, and stools of alder, growing near the margin of rivers and brooks, might be greatly lessened with the same advantage to the country at large, and improvement to the respective estates on which they are found. Hop-grounds, requiring a supply of small and quick growing timber for poles, occasion in some places a considerable quantity of land to be cultivated for this purpose. And as such plantations, as at present conducted, are unfavourable to the Climate, experiments should be instituted for ascertaining what kind of timber would be likely to last longest for hop-poles. Oak, during its growing state, I believe would be least injurious to the Climate; and if each pole were properly *charred* before made use of, there is reason to believe the coat of charcoal, formed on its exterior, would greatly contribute to prevent its decay; and thus lessen the quantity of coppice wood obliged to be kept up for the supply of fresh poles.

It may be a question with many, whether or not timber and forest trees, for the last forty or fifty years, have increased or diminished? This question is at present undetermined; and without being possessed of an accurate survey of the quantity of timber actually *then* existing in the country, to compare with the present, it must be difficult to decide. There is reason to think that two species of timber trees have diminished, *oak and ash;* as the shipping and internal navigation tend greatly to lessen the quantity of oak, and ash is the principal wood made use of in the construction of most kind of carriages for use or luxury. But, taking all varieties together, I have little doubt but *trees in general have increased during the period under consideration*; in a very considerable ratio, perhaps, several hundred for one.

If an accurate return could be procured from all the public and private nurseries for the last thirty years, there is reason to believe, that the aggregate number would be found great. However persons might have been inclined to make plantations forty or fifty years ago, they did not possess the facility of procuring ready-raised trees, which is now the case; the process of sowing seeds, and thus raising private nurseries, being too tedious, would deter most people from making the attempt, and trees, shrubs, &c. fit for planting, were not, as now, to be met with in the neighbourhood of almost every principal town from public nurseries. Let the great landed proprietors, who may feel disposed to doubt the position, respecting the increasing number of trees, procure a return from their stewards for the last thirty years of the quantity of timber fallen, and trees planted on their respective estates, I have no doubt but the general results will accord with my opinion. There have been undoubtedly, in some places, very considerable falls, without any new plantations; but on the other hand, when we consider the number of Mansions, almost annually erected from the wealth acquired by individuals in trades, commerce, and professions, both at home and abroad, with the numerous plantations made to decorate them; we shall be fully convinced, that trees are on the increase. In many situations, where a few years since a tree was scarcely seen, for instance on many of our high lands, we now behold extensive groupes, belts, and large plantations of pine, fir, beach, oak, elm, lime, sycamore, &c. &c. &c.; and, when we obtain a bird's eye view of some of our vale counties, they appear a perfect forest; as the vale of Worcester, seen from Malvern; the vale of Gloucester, from the hill at Frocester; or that of Middlesex, from Richmond, &c. If all the trees, shrubs, and hedges of every description, beheld from such eminences, were, in each district, collected into so many distinct woods, we should find, in all probability, that such a collection would approximate, if not rival in extent, the natural forests which are said to have existed some centuries ago; in the County of Middlesex, the Lombardy poplars only, without any other exotic, would, if planted together, make, in respect of extent, no contemptible forest; and, in many other Counties, from the new plantations, in addition to woods and coppices reserved for our own manufactories, the country wears a similar appearance. It certainly would be betraying a decided want of taste, not to allow, that the Moderns have much improved on the plan of our Ancestors in ornamental gardening, and the mode of forming plantations; our ancient avenues, and formal rows of trees, were very unpicturesque, says the modern planter! In answer to which our Ancestors, had they lived to see the present change of Climate, might have retorted, by observing, that their avenues formed an agreeable shade, which is now rendered unnecessary by the almost perpetual curtain of vapour existing between us and the Sun, which effectually answers the purpose without such aid. Every person of true taste, however, must allow, that many modern parks and plantations of the Nobility and Gentry in this country, assume the appearance of the real picturesque. In numberless instances, art has been very judiciously concealed; in fact, Nature has been imitated with such success, that an American, it is said, has declared that "he abhorred an English park, because it put him so much in mind of an uncleared country, where venomous serpents hid, beasts of prey lurked, and dangerous damps lay concealed; but, from an association of ideas, he liked straight hedges, avenues, and roads, which implied the dominion of man. *(Holcroft's Travels from Hamburgh to Paris.)*

In some instances those who have laid out pleasure-grounds have "overstepped the modesty of nature." This is generally the case with the best system; the margin of wood which now forms the boundary of many parks, often presents a disgusting appearance to the eye; the artful contrivance of this uniform orbit of trees, may be compared to the box-edging, encircling a gay parterre; the landscape might often be much improved by admitting views of the distant country; even supposing a barren heath were partially admitted in the view; for this gives relief to the eye, by affording variety to the scene, and by increasing the general effect through the aid of *contrast*. There are few ornamental plantations which may not be improved, and consistently with the sublime, beautiful, and certainly with the *picturesque;* by thinning out a portion of the trees and shrubs. From the present rage for forming grouped plantations, the trees are by far too much crowded together to appear to the best advantage; and though occasional groupes may contribute to beauty, by producing a variety in the landscape; yet the whole plantation, when thus in close assemblage, tends to produce *only a dull uniformity.*

It is the usual practice with designers of pleasure grounds (because young trees and shrubs shelter each other better), to plant a much larger number than are intended to remain after the plantations have acquired some height; and when they are grown up many are thinned out to enable those which are left to expand their lateral branches. In performing this business, great attention should be paid to the removal of such trees as exhale much moisture, or protrude their foliage early in the Spring; because we cannot expect to restore the vernal Climate to the state it was forty years ago, unless we diminish the *number of vegetables*, which produce a great quantity of vapour at this early Season; *blue mists and damp air, now so productive of blight, cannot be prevented without an attention to this circumstance.* In every soil that will bear the English oak, it should be preferred, and the surrounding trash in plantations occasionally be removed, that the true Heir of the Soil may enjoy every advantage of light and warmth, to expand its beauteous branches and erect its dignified trunk.

An Englishman should ever cherish this Pride of the Forest, as affording the principal material used in the construction of those floating castles which have preserved the national independence, and enabled so many living, as well as departed Heroes, to extend the fame, and increase the wealth of Britain. A most honourable Order of Knighthood might be judiciously instituted in favour of the British Navy, and the *Oak* become .ts Ensign; and such honour be exclusively reserved for those who, by their prowess, skill, and intrepidity, have hitherto been, or may hereafter become the means, under Providence, of securing to these sea-girt Isles the Sovereignty of the Ocean; the distinction would be more appropriate, and the Badge of Honour, surely as estimable, as either the *Bath* or *Garter*. In plantations of deciduous trees, next to the Oak, the Beach and Ash perhaps are entitled to a preference; as both come out late in the Spring, are of quick growth, and are exceedingly useful when they become timber. The pine and fir tribes *(except the larch)* are evergreens; they exhale but little, save for about a month, during the protrusion of the new shoots, which are not fully expanded till the month of June; but poplars, elms, horse-chestnuts, limes, sycamores, alders, willows, planes, acacias, &c. should give place, when the thinning of plantations is thought necessary, to the more valuable species of trees. The occidental and oriental planes certainly exhale much moisture, but then they possess a salutary advantage over other trees, that of coming out late in the Spring; and they form a pleasing contrast with the oak, by the brilliant green displayed in their foliage.

Those whose study or profession it is to form ornamental plantations, should endeavour to produce effect with as *few trees* as possible; and this may easily be done by a judicious selection of low-growing varieties to be placed in the fore, and those of higher stature in the *back* ground. The picture might be frequently much heightened in point of beauty, by studying the different *tints of trees*, and placing those which have a bright foliage in the more prominent parts of it; as the margin of the walks, the water, or swelling eminences of the ground, and the deeper tints in the recesses or vallies; for a very *deep* and *distant* shade, the Scotch pine is perhaps the best adapted. A scene-painter, from being in the habit of studying the effect of light and shade, would be a proper person to employ in laying out extensive plantations; but it should be one who has been accustomed to place the *dark* and *indistinct* parts, and the *clear* and *distinct ones*, where Nature has placed them; the former in the *distant*, and the latter in the *near-approaching*, prospect. Some attention should likewise be paid to the style of Architecture in which the mansion is built; if the building is in the style usually denominated *Saxon*, or *Gothic*, it conveys the idea of aristocratical grandeur in the early and middle ages; the trees and shrubs surrounding which, should none of them be *exotic*; for how can we associate the idea of ancient English grandeur with Carolina poplars, planes, acacias, scarlet oaks, &c. when we reflect, that the country (America) from whence these trees were imported, was scarcely known by us to exist three centuries ago? It is procuring absurdity and incoherence at an useless expence. The effect of the venerable and unique mansion (neither Gothic nor Grecian) of Sir John Packington, Bart. situated in Westwood Park, Worcestershire, is much increased by the fine full-grown oaks that surround it; and even the straight avenues which form the different approaches to the mansion, contribute to give effect to the whole, and produce in the mind an idea of ancient English grandeur that is seldom experienced in viewing castellated mansions of older Architecture, when surrounded with trees whose foliage proves them to be of modern introduction.

The *elm trees* which we so frequently meet with in hedge-rows, are very injurious to the growing crops of grain, both by rendering the air humid, occasioning shade, and, in seasons of drought, exhausting the soil of the necessary moisture, by the absorption of their expansive roots. If these trees are of absolute use to the estate, they should be placed in a coppice by themselves; the effect of trees in hedge-rows being universally allowed injurious to corn, from their occasioning shade, and preventing the due circulation of air, It is to be hoped, that future agriculturists will attend to this important, though neglected circumstance, In this clouded Climate we have often two or three hours sun early in the morning, and late in the afternoon, since less cloud is formed at these times, owing to the vegetable exhalation being not so great, as in the middle of the day; and our crops of grain would then be much benefited by this sun if there were no trees in the hedge-rows to occasion shade: a tall elm tree, in the morning and evening, will occasion a portion of shade to extend in length over a very large space of land. The beauty of the country too would be rendered much more picturesque by having all the trees in coppices, and the shade then would not be injurious to the grain, as the coppices might be planted only near the *pasturage* belonging to the farm.

It has long been the practice in Worcestershire to lop off all the lateral branches of elm trees in hedge-rows, once in six or seven years; this, I grant, entirely defaces their beauty, but is of great advantage to the country, by lessening the exhaling surface, and diminishing the shade. If the branches are cut off smooth and close to the trunk, the timber is not much injured, for the cicatrice is soon covered by the contiguous bark, and layer of new wood, which prevents a caries from forming. However, it must be allowed, that a *knot* is always thus formed in the timber; because the new wood never unites with that which has once been injured and exposed to the air*. Some landlords have lately refused their tenants the privilege to lop their elm trees, which is a restriction very unfavourable to the Climate, and particularly injurious to the crops growing in their vicinity. Where such trees are not within sight of the principal mansion of the landlord, the tenant should be allowed to lop as formerly was the case; and the oftener in season this operation is performed, the less the timber will be injured; as the wound will be of less dimensions, and of course sooner healed.

The elm being a native of the south of Europe, does not, as we have before observed, afford seeds fit for propagating the plant in this country; but has the property of sending numerous suckers from its roots, which, springing up in the hedge-rows, where defended from cattle, they soon increase to trees. The timber afforded by the elm is not very valuable, because peculiarly liable to the dry rot; its principal use is in pipes for the conveyance of water under ground, or as foundation piles. Mr. Brindley, the celebrated engineer, thought *pine* equally good, if not preferable, for the latter purpose. For the last half century, since the introduction of foreign fir for building, elm trees have, in some places, much increased, from the facility with which they spontaneously spring up in hedge-rows; and when thus suffered to spread themselves, without being thinned, become very injurious to the Climate. To adduce no other proof of this, while the price of deal has been rapidly rising, that of elm has nearly been stationary; and though much has been used in our dock-yards for *keels*, and *lower ribs of vessels*, yet, from the rapidity of the growth, and the long prevailing fashion of adopting a foreign timber for building purposes, there cannot be a doubt but this species of trees are daily increasing.

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* Mr. Knight has judiciously observed, "that an incision or wound on a fruit or forest tree, is only covered by new bark and wood, but not united."

The effects of a humid state of the air, and want of proper ventilation in favouring the growth of *moss* on apple and pear trees, is very conspicuously seen whenever trees are suffered to become thus numerous; and the cause is obvious: Moss, as it radicates very superficially, cannot long exist without a great degree of moisture, which, from the organization of the plant, it has the power of absorbing from the atmosphere; but then it must be in a humid state. Trees are so great an ornament to a country, that it is not at all surprising that persons of taste feel a disinclination to their removal; but, with respect to economy, I am persuaded that, notwithstanding the facility with which the Climate of England favours the growth of timber; in a national point of view it is more politic for this Country to import the timber used in building than encourage its growth at home; at least in the *southern* and *midland* counties, or in any other parts of the Kingdom favourable to the production of grain. A proper supply of oak must doubtless, if possible, be inviolably preserved in every part of the Kingdom, especially near to our *Naval stations.* The timber generally used for houses and carriages of every description should be principally grown in the northern counties, or Scotland; parts unfavourable for the growth of corn; we should then experience an essential improvement in the Climate of our finer provinces. The genus pine, with many other trees, useful for these purposes, succeed well in Scotland; and the growth of such timber, on some of the waste lands in that part of the Island, would produce national advantages, as well as individual wealth. It would, in the first place, increase our coasting trade, by the number of vessels annually employed to carry such timber for the use of the southern parts of the Island, and thus contribute towards a nursery for seamen; in case we should, at any future day, lose a part, or the whole, of our distant colonies, either by internal revolt, or by a superiority of naval power, placed in the hands of our enemies. The insular situation of Britain enabled her to raise Seamen enough for her own protection, before she possessed any colony in tropical Climates, (as witness the defeat of the Spanish Armada); and if her national resources are properly applied, she will ever be able to preserve her independence as a nation; even supposing the calamity of the loss of her distant colonies to happen: an event, from the insidious arts of our inveterate enemy, and the separate interests arising from such distant connections, not unlikely, at some future period, to take place; not to mention the unexampled power assumed and maintained against the combined and reiterated force of Europe, in the erection of the new Empire of *Hayti*.

Although a reduction of the number of trees in South Britain may injure the beauty of the country, the solid advantages to be derived from it, will amply remunerate us for such kind of loss; trees and verdant fields certainly afford a more picturesque landscape than the patch-work or harlequin appearance (as it has been termed) of arable lands; but the latter convey such an association of health and plenty as perfectly to compensate for their want of beauty. I never travel through an extensive rich arable district, divided by large inclosures, but I associate the idea of a pure atmosphere, a numerous and happy peasantry, athletic, bold, and ever ready to obey the voice of their native country, when called upon to defend and secure their liberty from either a foreign assailant or domestic foe. But when I observe high vegetable fences, rows of trees, and luxuriant pasturage in the small inclosures which generally surround our large towns, I connect the idea of a clouded atmosphere, a half-starved peasantry, driven, for want of employment, into towns, where, from confinement in close and crowded manufactories, they soon exchange their once ruddy complexions for a pale meagre visage: the loss of health is too commonly and fatally attended also with loss of morals, and, from the contaminating effects of vicious example, many become initiated in the low and wicked arts of chicanery and fraud. A singular opinion has lately been advanced respecting the increased price of the necessaries of life—which is, that the consequent advance on labour is advantageous to our manufactories, because it gives encouragement to the more general introduction of machinery. Those who have adopted this idea will find, on more mature reflection, that this is not exactly the case; the saving of labour is undoubtedly a principal inducement for using machinery; but there are other and more powerful inducements which will ever give machinery the preference to human labour, and that is, that machinery is more to be depended upon; men may be idle, by being addicted to drinking; they may incapacitate themselves for labour, steal, or betray the confidence of their employers; and as machinery lessens these inconveniences, the use of it will ever be superior to that of human strength, wherever it can be adopted; even though it should prove equally expensive to the manufacturer, and its influence occasion little depression on the general market.

CHAPTER XIV.

Not to place too much Reliance on Foreign Commerce.

THERE is great reason to suppose, that whenever the peace of Europe is permanently restored, (an event which we hope, for the sake of humanity, will speedily happen) that we shall not possess so large a portion of Foreign Commerce as we have done for the last twenty-five years. The powers both of the Eastern and Western Continents know that it is from Commerce that we have obtained our superior wealth and gigantic power; the English are the envy of all surrounding Nations—both to professed friends and to declared enemies. The ruling powers and leading characters in each Nation, will devote their attention with unremitting diligence to the same means of gaining riches and acquiring power; till at length trade will defeat its own purposes: more natural productions will be raised than can possibly be consumed, and more artificial ones manufactured than can find a market, and a general stagnation of Foreign

Commerce must then be the result. Those Nations will then be in the most eligible situation, who can support a numerous population without such foreign connexions.

I am far from wishing, by these remarks, to depreciate the advantages of Commerce; on the contrary, I sincerely wish that Great Britain may retain her proud pre-eminence, or at least share in the wealth and comfort derivable from this source to the latest posterity. But it must be allowed, *that it is possible for a nation to become too commercial, and thus fall through the very means by which it has risen to opulence and grandeur:* that is, from an increase of luxury, the natural consequence of wealth, and from the great facility it affords the Government of such a commercial state for borrowing money in time of War. The latter evil has occasioned in this Country the alarming accumulation of debt, the contemplation of which makes every real patriot shudder for the issue:—The interest of more than six hundred millions sterling, which interest is now annually to be raised, in addition to the current expences of the year. But man can only gain knowledge by experience, and the policy of future ages, it is to be hoped, will point out to them the propriety of inserting in the coronation oath of every Potentate on earth; that he or she shall never consent to anticipate the public revenues of their respective states in time of war. Such a concession from all the different Potentates, or Governors of Nations, to their respective subjects, would tend to lessen the sufferings of humanity, arising from the numerous evils ever consequent on war; this terrible scourge would not then fill the pages of history, for successive periods of years, as it now does. This system, so destructive to the human race, would then have some countervailing limitation; the national treasures on all sides would sooner be exhausted; and, like a law-suit between two persons, who have each spent their finances, their differences must be amicably adjusted from reciprocal necessity. Fortunately for us Nature has bestowed on England such advantages as, if properly attended to, will ever enable her to preserve the independance of the Nation, and supply its own wants, without expending our wealth on the productions of Foreign countries.

Even supposing that Great Britain should continue, for half a century, to possess an export trade for her merchandise and wares, so as to raise sufficient revenues to liquidate the national debt; still it would be a wise policy to endeavour, as far as possible, to supply those wants at home, especially with those articles to which our soil and Climate is adequate. The reduction of pasturage, and introduction of tillage, should, by all means, be persisted in; till, on the average of ten years, it should appear, that we can support ourselves in the necessary articles of life. This may be effected without any material diminution of animal food. Those who have so much improved the breed of our native animals, may continue their experiments on crossing the Leicester breed of sheep with the South Down, &c. or the Hereford cattle with the Wilts or Devon, in the same enthusiastic manner as of late; but as these animals are now probably brought to the acme of perfection, at least for all useful purposes, it is to be hoped that some of the premiums of Agricultural Societies for encouraging improvements, may be directed to *other and more important objects*: as who shall remove most useless trees, or exchange hawthorn for holly fences—or convert the greatest number of acres of grass land into permanent tillage—or feed their horses with the least proportion of hay*—or lessen the necessity of canals, by rendering natural rivers navigable, at a small expence—improving roads by iron rail-ways, or other means—thus diminishing the number of horses, lessening the poor rates by diverting the hand of industry to profitable labour, and to many other useful topics which might be suggested.

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* This practice, I am happy to find on enquiry, is gaining ground in the stables of Inn-keepers, who now begin to find their horses stand work better with cut straw and corn, than with hay and corn.

It is too obvious to be denied, that the National industry of the labouring classes may be better kept up by employing a large portion of the Population in agriculture than in manufactures; as, when employed in the latter, they often earn too much money, and the Monday and Tuesday of each week, if not more days, are frequently spent in an ale-house, instead of their proper employment for the benefit of their family. This is more or less universally the case, but those who have visited Manchester, Birmingham, and most manufacturing towns, on a Monday or Tuesday, cannot but have witnessed the truth of this remark: indeed high wages are ever, where a religious principle does not give a spirit of economy, not only injurious to the Public, but the individual. If, as Dr. Smith justly lays it down, labour is the wealth of a commercial and trading Country, then whatever tends to diminish the proportion of labour, must be injurious; and those accustomed to labourers in general know, few will work longer than stern necessity urges. At present there is great alarm throughout the British Empire, caused by the growing Military power and influence of France, lest, when the peace of Europe is restored, the commercial rivalship that will ensue, should ultimately wrest from us a part of the principal source of our wealth; and so far as respects Native produce, as before observed, we must allow that France possesses a decided advantage over England, in enjoying a more genial climate, and in having her agriculture free and unshackled from tithes and other feudal claims: the cultivators of the soil in that Country have now no impediments to improvements of this kind; and however their manufactures and commerce have been for a time injured by the Revolution, it must be allowed that their agriculture has been essentially benefited by that great event. However, there is one consolatory reflection for this Country; the late restoration of a Monarchy founded on and supported by military despotism, may be considered as favourable to England; so far as it regards the future commerce of the Nation. A Military government will ever prove unfavourable to Commerce, from a variety of causes; few men will venture to exert their industry and embark their capital in a Country where the concerns of the State depend so much on the whim or caprice of a single individual, who may, by some sudden ambitious project, expose his merchants and manufacturers to instantaneous and utter ruin. A recent instance of this kind happened in the sudden restoration, and as sudden abandonment of the celebrated Seve (late Duc

D'Angouleme's) *porcelain manufactory*; by which the proprietors have become insolvent, and all the remuneration they have been able to obtain from the State is, *a protection of their persons to enable them to evade the honest demands of their creditors.* Again, the recent failure of a considerable number of the most wealthy bankers at Paris, by means equally fantastic; will consequently involve great numbers who had deposited their property on speculation. In fact, under an Arbitrary Government, especially when the power of that Government is founded on Military principles, and supported by Military coercion, there is little chance of its raising itself to wealth and greatness by trade and commerce. Taking all circumstances together, then, England need not despond; her manufactures may be abridged, and her commerce reduced, but not destroyed; and whenever this event happens, it probably will not be attended with such lamentable consequences as some persons are disposed to expect; but, on the contrary, a moderate reduction of our commerce will, in all human probability, save the Country, by preserving the integrity, exerting the industry, and improving the morals of the people: and thus preventing the baneful effects which the great influx of wealth and consequent luxury have produced.

CHAPTER XV.

On the Influence of Inclosure-Acts, &c.

MOST of our modern writers on Agriculture have strongly recommended a general inclosure of our common fields and wastes, but if such a measure were adopted on the part of the Legislature, and the usual rural economy of small fields, and intersecting them with hawthorn fences continue; I have no hesitation in saying, that the effect on the Climate would be baneful: for, so far from increasing our staple esculent commodity, we should absolutely grow less wheat, which is unquestionably the most valuable article raised from the soil; spring frosts, fogs, and cold summer rains, would become still more prevalent than they at present are; the wheat would scarcely ever escape the mildew; especially the variety called Lammas, the most desirable for this Country. Barley might produce a crop, but the grain would be of very inferior quality, like what is produced in Ireland*.

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* I have never seen barley imported into this country from Ireland that has exceeded in weight forty-eight pounds the Winchester bushel; when in the same seasons that the same quantity of such grain, grown in England, has weighed fifty-two pounds and fifty-three pounds.

Amongst other schemes for making the most of the land, it has been proposed to plant our mountainous districts with trees, which would increase the calamity ten fold; for, if these elevated surfaces were entirely covered with wood, owing to the conducting and exhaling influences, we should probably not have a single dry day from the 20th of April to the latter end of September. In our Northern Latitude, and surrounded as we are by the Sea, we find the Atmosphere already so vapourous, that the Sun is frequently obscured during a great part of the Summer; and if we should thus increase the exhaling and conducting surface, we should seldom have a ray of sunshine to enliven our spirits, or to ripen our corn and fruits during the summer months. To prove the unfavourable influence of frequent humidity on the blossom and filling of wheat, let the variety of this grain, which we have just alluded to, Lammas, be cultivated in the County of Lancaster, and compare the produce with the more dry southern or eastern Counties; it is not the cold but the humidity of the County of Lancaster which prevents its growing wheat to the same advantage experienced in drier air*.

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* "About Liverpool the land seems not fertile, though well cultivated; the north-west wind depresses their sickly forms; and, like an infant towards its flattering mother,

Inclosing our dry heaths and commons with living fences, and cultivating the land with corn or grass, produce effects similar to the crouding of a hot-house, so as not to leave an inch of surface unoccupied, by different varieties of vegetables, without extending the atmosphere in which they grow. The result of this practice in conservatories, experience has invariably proved to be bad; and there is reason to think, that the extension of our agriculture and pasturage, beyond a certain point will render our Climate, in Spring and Summer, very precarious; and, on the average, our seasons will be less propitious to the culture of corn and fruits than they have hitherto been. The arguments against extending our agriculture, so as to clothe our barren heaths with a luxuriant vegetable surface, (the injurious tendency of which, in this already too crouded Climate, has, we trust, been satisfactorily pointed out) do not, by any means, include proposed improvements in our woods, morasses, or any other moist exhaling ground; on the contrary, the better cultivation and draining of these are highly favourable to the

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stretch their hands to a more genial Clime. The herbage looked uncommonly green; but the growing corn appeared dingy and black. The verdure of the other arose from the abundance of rain."—*Vid. Mawman's Tour to the Lakes, &c.*

Climate, and should be as much promoted as possible.

As the Population of the country increases, it will necessarily occasion an extension of cultivated surface; and we shall then find it to be of greater importance than ever, to remove, not only superfluous trees, but every blade of grass which exhales for no useful purpose; that the atmosphere may be preserved in a proper state to suit the culture of the more useful and essential classes of vegetables. Dry heathy commons, where the vegetable surface is scanty, like fallow fields in sunny weather, heat the air in contact with them, and increase its capacity for moisture; so as to absorb the vapour exhaled from the cultivated fields, trees, quick hedges, &c.; thus contributing to dissolve clouds into transparent air. Not only England, but all the European Continent, will revert, in point of Summer Climate, when the Population increases, so as to require the general culture of dry barren land; though, for the last eighteen Centuries, the reverse has been the case, from the reduction of exhaling surface, by the culture of such land as was previously in the state of wood and morass. So well persuaded am I of the truth of the principles I have advanced, in respect to our Climate in future, during Spring and Summer, that it would be a desirable thing, in subsequent

Inclosure Bills, that, amongst so many other restrictive clauses, *one were regularly introduced, to prevent the inclosing with any kind of obnoxious fences, especially hawthorn; and another to enact, that the respective fields should not consist of less than ten, fifteen, or twenty acres, according to the circumstances of the portion of waste to be inclosed.* There would be much less objection to Furze, or Holly as a fence, or any other vegetable which does not protrude its vernal foliage too early in the Spring, or exhale much moisture in Summer.

The same inconveniences attending inclosed land, in encouraging pasturage rather than tillage, were felt when the system was first generally practised, about three Centuries ago; for, according to Lord Bacon, Henry the Seventh wished much to encourage Agriculture, and thus render the cottagers and villains independant of the great Barons. Guthrie, in his History of England, says, speaking of the state of the nation in 1490, that " The late civil wars (between the houses of York and Lancaster) had nearly put an end to Agriculture, almost to the depopulation of the State. An infinite quantity of arable lands were now necessarily turned into pasture; industry was thus contracted within a very narrow sphere; villages and towns were left empty; the Church was deprived of its tythes, and the King of his most valuable subjects. But this vast use of pasturage had one great advantage in it, which was, the encouragement of inclosures; for it does not appear that it was then much the practice to inclose arable land. The great art therefore was, to convert these inclosures, without discouraging the practice, into arable land, and thus to prevent *depopulating pasturages*." This was done by an ordinance, enacting "That all houses of husbandry that were used and occupied with twenty acres of ground, should be manured and kept up for ever, together with a competent proportion of land to be used and occupied with it." This act, as my Lord Bacon very justly observes, in a manner forced the occupier of such houses as are described in the same, to raise themselves above the degree of cottagers, or *villains*, and to become men of property and substance."—*Guthrie's Hist. of England, p.* 795.

The deep and sound policy of Henry was very conspicuous in this business, and proved of great advantage to the monarchy, by the creation, or rather extension, of that useful class in community, an independent yeomanry; and increased Population, by encouraging Agriculture; which enabled the Country to raise soldiers without hiring Foreign troops; as was the practice in France and Italy. And as Lord Bacon *quaintly* expreſsed it, “Thus did the King ſecretly ſow *Hydra's teeth*, whereupon ſhould riſe armed men for the ſervice of this Kingdom.

CHAPTER XVI.

On the Influence of aqueous Surfaces on the Climate.

IT has already been shewn, that Agriculture improves a Climate disposed to coldness and humidity, by occasioning less cloud; thus admitting more heat and light to warm and fertilize the earth, and by dissipating less heat in the process of evaporation. Hence it is evident draining of land, fallowing the ground, and the formation of wide turnpike roads, tend to ameliorate the Climate of this country; but artificial Irrigation, and the increase of aqueous surface, by making Artificial rivers, ornamental lakes, floating docks, &c. increase the disposition to cloudiness, and consequently to coldness and humidity. Within the last thirty years, an enormous aqueous surface has been presented to the influence of the Sun and Air, by the formation of numerous Canals, for the conveyance of merchandise, under the denomination of Inland Navigation. I do not mean to question the utility of these Artificial rivers, in facilitating commercial intercourse, and as affording a cheaper method of conveying wares and merchandise from one part of the Island to another, more especially the heavier articles: The spirit and industry, so peculiar to the English Nation, has perhaps in no instance shewn itself so conspicuously as in these expensive and ingenious works; but an extension of aqueous surface must be injurious to the Country, as materially affecting the health of the inhabitants; and therefore unless very unusual *local* or *general* advantages are to be derived to the Community, where new canals are projected, the People ought to pause, before they give their consent to the furtherance of such sources of incalculable evil. By considering Canals as an *auxiliary*, I am very far from supposing them to be *the sole Cause* of the late coldness and cloudiness of our Seasons; the principal causes will be found to be those which have been already enumerated; otherwise we should not experience such fine clear Autumns as we generally of late years have done, after the crops are removed, and vegetable foliage begins to lose its activity in exhaling moisture. As the evaporation from Canals are as great, and indeed greater, in the Autumnal than in the Vernal season, still there is little doubt, but *they, in* *a degree*, contribute to increase the vapour and cloud of our unsettled atmosphere. Water is not so much heated upon the surface by the Sun's influence as Land; for, being transparent, the rays are admitted so as to heat it to considerable depths; whereas the outward crust only of the earth is heated, and, from different reflecting particles, this heat is communicated *downward* very slowly. As far as the results of my experiments have gone, I am disposed to think evaporation from Water is greatest, when such Water is at a higher temperature than the air, and least when the air and Water are precisely at the same temperature.—*Vid. Hamilton in Irish Philosophical Transactions.* Vegetable surface is said to exhale one-third more than aqueous surface.—(*See 2d Vol. Phil. Trans. page* 150.) This must depend on the nature of the vegetable surface. Tracts of land covered with luxuriant crops of grain, grass, or extensive woods, during part of the year, exhale more than the same space covered with water; but taking in the *whole Year*, including night and day, perhaps the same extent of aqueous surface may be found to exhale more than vegetable: the reason of which is, that, in a calm night, vegetables, according to the ingenious and accurate experiments of Dr. Hales, give out but little water to the Atmosphere. In fact, the process, as to vegetables, is the reverse; for, in a calm state of the nocturnal air, trees and plants increase in weight by the absorption of dew; but aqueous surface having been previously heated in the day, affords a very large quantity of vapour to the cold air, which descends to the earth, during a calm night; unless the cold is so great as to produce congelation: and even then it has been proved, that the evaporation still goes on.—*Vid. Watson's Chemical Essays.*

After a hot day in Summer, I have found that our rivers, canals, ponds, &c. if fully exposed to the Sun, are heated to seventy degrees; and the cold air which descends on us in a calm night, is frequently cooled below fifty degrees; the difference of temperature being thirty degrees, our rivers, canals, &c. smoke like a boiling caldron, and the vapour, or, as it is usually called, *fog*, is seen hovering over them till after sunrise, and again late in the Evening. It is most perceptible if the observer be situated upon an eminence, at some distance from such canal or pond. Fresh water lakes, or rivers, probably give out more vapour in proportion to the surface exposed to air than the saline ones; for we find that pure water boils at two hundred and twelve degrees; whereas, sea-water requires to be heated to two hundred and twenty-three degrees by Fahrenheit, before it begins to boil; and we find that, if substances are moistened with the following liquors, they evaporate at the common temperature of the atmosphere, with more or less rapidity, according to the respective temperature or degrees of heat at which they boil. Thus, if a board be moistened separately with æther, alcohol, and water, the æther will dry up first, then the alcohol, and lastly the water; and as these liquors boil at different temperatures, we may presume that *fresh* and *salt* water follow the same laws; I am therefore inclined to think, that experiment will prove our rivers and canals do evaporate more, in proportion to ther respective surfaces, than the *Sea*.

Independently of the unfavourable influence which Canals have on the Climate of this Country, there are other considerations of high political importance which imperiously call on the Legislature to withhold their sanction, in some particular cases, from the further extension of the *Canal system*. The particular cases here alluded to are, when these artificial rivers are intended to convey produce *from one sea-port to another*; thus if Canals were made to communicate from the Counties that raise a surplus of grain on the eastern side of the Island to those which consume this commodity on the western side; as, for instance, from Norfolk to Lancashire; such an internal navigable communication might perhaps add wealth to individuals, or facilitate the conveyance of grain, without risquing the article to damage, or loss by Sea; but, in a national point of view, it would be impolitic in the extreme: as such communications through the interior of the Island, would lessen the Coasting trade. A sailor may be as perfectly initiated in the art of navigation and its tactics by sailing from Lynn to Liverpool, and from Liverpool to Lynn, as by a voyage to the West Indies; and, in seamanship, ten fold more: but the dragging of a canal boat can give a man no more the idea of ploughing the trackless Ocean, than the driver of a waggon could, by such occupation, learn the art of surveying. Parliament has, I grant, not overlooked this circumstance, as may be seen by the restriction on the Paddington canal, not to carry coal to the Metropolis, lest it should injure the Coasting trade to Newcastle. Yet perhaps still further caution is necessary; an Englishman should ever keep in view the possibility of losing our colonial intercourse in the eastern and western parts of the world, and also the best guardianship, our maritime defence. But so long as the Climate of the eastern side of our Island continues more dry and favourable to the production of grain than the western, we must continue to possess a Coasting trade, and thus have respect to a certainty, rather than an uncertainty, in a case of such generally-acknowledged National importance.

CHAPTER XVII.

Imperfection of our Meteorological Knowledge—Means of extending it, &c.

METEOROLOGY is a science at present quite in its infancy, although philosophers have, for centuries, acknowledged its utility; yet, from various causes, little progress has been made in elucidating the process of Nature, that is daily and hourly impressing our senses with effects which produce no trifling influence on our health and happiness; one day we exclaim the weather is fine; but it will not last—and why? because a neighbouring Invalid complains of rheumatic pains; or the fish leap on the surface of our ponds; or the leech is in motion; or mare-tail clouds are seen in the sky: but none attempt to inform us, why such omens forebode a change of weather. Lord Bacon has written voluminously on the subject; but in his days this branch of science could make little progress, for want of instruments calculated for experiments of this nature. About the æra of this great man's death, two very important ones were invented, the thermometer, by Drebbel, and the barometer by Torricelli; the former shewing the variations of temperature, the latter the weight or pressure of the aerial Ocean in which we exist; since which time the hygrometer and electroscope have been invented. The hygrometer is the most imperfect instrument we at present possess, as it does not shew the actual quantity of water dissolved in atmospheric air, or combined with it; for no two instruments of the kind are so exactly formed or graduated, as, under different degrees of temperature, to enable us to make a just comparison: it is likewise liable to variations from currents of air, where the quantity of moisture is precisely the same. When we are better acquainted with the powerful effect of electrical agency in producing changes in the state of the Atmosphere, I am well persuaded that the *electroscope* will be found to be an instrument of the highest importance.

Possessed of these mechanic aids, we have great advantages over the Ancients; and in these times, where every other branch of science is making such a rapid progress, it is a matter of surprise and regret, that we yet possess so little information on this subject! Storms, attended with peculiar meteorological phænomena, are frequently happening; electrical influence, on a vast scale, often surprises us with exhibitions of such wonderful, sublime, and awful effects as to appal the courage of the stoutest heart, and even to awaken in the breast of the infidel sensations of terror and alarm. Mr. Kirwan, with great propriety, observes, that "there is no Science in the whole circle of those attainable by man, which requires such a *conspiracy* (or such a combination of means) of all Nations to bring it to perfection, as Meteorology; nor is there any perhaps more conducive to his security and comfort." In fact, local remarks cannot enable us sufficiently to extend our knowledge on this subject; observations in one Kingdom, or even in one *Hemisphere* alone, can never effect this great and desirable work; observations must be simultaneous throughout the Globe, and made, if possible, in various Climates and different degrees of latitude and longitude; otherwise we cannot trace the connection with each other, of the phænomena observed. Many learned Societies throughout Europe have proposed, and some, as those of Manheim and Paris, have made, very useful enquiries on the subject, as well as ascertained very important facts, by the answers received to many of them. Mr. Kirwan's remarks on the temperature in different latitudes, with the causes producing the variations of the annual medium, caused by the elevation of the land above the level of the Sea;

and the influence of exhaling vegetable surface, or dry, stony, or sandy soil; is a work that will prove of great assistance to those who are desirous of Meteorological enquiry. As yet the observations have been much *too local* to enable us to trace the progress of winds and storms; however, it may be hoped that polished and learned Nations will, at no distant period, unite in exerting themselves for the furtherance of a Science so nearly connected with the interests of agriculture, of commerce, and of health; and consequently with the wealth and happiness of all civilized Society.

"The study of Meteorology, says Mr. Kirwan, differs from other branches of natural knowledge in this, that it does not enable man to alter the spontaneous course of Nature, except in *very few cases;* such as the alteration of temperature by promoting or checking vegetation, draining morasses, &c." There is great reason, however, to think that we may venture to expect far greater effects than these; there is no saying how far the mind of Man is capable of extending his researches into Nature; and how far, in future, those already made may enable him to make more. If we were to take a retrospective view of the innumerable improvements during the last Century, we should think that every lover of science would be careful, on those occasions, not to cast a damp upon the spirit of, nor depreciate our actual progress in, improvement. What has been so progressively done proves the ratio, and that it is of such importance as to defy such kind of controul; and we may, at some distant period, even attempt the amelioration of the weather, or at least to counteract extremes of drought or moisture; and perhaps even to precipitate the fruitful shower, or admit the genial influence of the Sun, as the wants of animal and vegetable life may appear to require. A further knowledge of electrical agency will doubtless, ere long, enable man to obey the command of his Maker—" To *replenish the earth and subdue it.*" Such an idea may perhaps be thought extravagant by some; but such I refer to those wonderful and useful discoveries which have been made, and lately made, in equally abstruse branches of knowledge; as in Astronomy, Navigation, Chemistry, and others, which to detail would be superfluous. The half-brained witlings, who were contemporary with Bishop Wilkins, no doubt ridiculed the prediction of the philosophical Prelate, when he asserted, that *men would, at some future period, soar aloft in the atmosphere like eagles;* but had they lived to see the *aerial voyages of a Mongolfier, a Lunardi, or a Garnerin,* they would have corrected their ignorance; nor would their folly have descended, as it has, to Posterity. In fact, so long as it shall please the Deity to continue the operations of Nature, and his greatest blessing to man, Reason, Natural Knowledge will progressively advance; and none *can* or *ought* to say *how far* human researches and human knowledge shall extend.

In addition to the circumstance of the vine maturing its fruit, so as to produce wine in England five hundred years ago, and not at present before adduced; there is another which shews, that the Climate in our days has changed in point of salubrity, which is, a declination in the health of the Human Species. The corporeal debility, now so much complained of, was totally unknown some Centuries ago, for proof of which the present race of men cannot (according to the testimony of our medical Professors) bear the copious evacuations and potent drugs, which were prescribed some centuries past. Again—let a modern professor of the Military art put on the ponderous coat of mail as worn "in days of yore," with the usual appendage of helmet, shield, &c. the ability to do this, and wear it for a whole campaign; would be a fair criterion whether or not the Moderns have improved in health and strength, and the result would be conclusive.

In our attempts to assist Nature in agriculture and medicine, we doubtless frequently commit errors, and counteract our own intentions; but if our efforts proceed from a good motive, that of benefiting Mankind, we have every reason to believe our endeavours will be pleasing to the Deity. If the scarcity of grain in 1795, and again after the harvests of 1799 and 1800, could have been averted by human art, and the consequent sufferings of the poor been prevented by its efforts; surely such benevolent service would have been acceptable, and obtained favour from the Father of our Spirits. Our reliance on God is not lessened because we plough the land and sow Corn, rather than trust for our subsistence to the precarious productions of unassisted Nature; nor would it be by our Art, if we should discover any method of controuling the irregularities of the weather, and ameliorating the Clime. But our principal reliance must ever be on God, without which the most ingenious labours of man will be in vain. Suppose the same omnipotent Being that, once in the sublime language of Scripture, said, " Let there be light," were to suspend the regular course of Nature, but for three days, by withdrawing the influence of the Sun; in all probability animal and vegetable life would cease to exist, owing to the deprivation of light and heat, their essential supports. Having shewn that any attempts to improve the Climate of the Country in a more direct way than has hitherto been done, are not inconsistent with that Divine Revelation, which we can never too highly prize; it is proposed to suggest the possibility of effecting a change in the *electric state of the lower stratum of air throughout the Island of Great Britain, at those times only, when the extremes of heat, cold, drought, or wet,* are so considerable as prove the efficacy of some change being beneficial to animal and vegetable life. Previously to entering on this part of the subject, it may not be uninteresting to suggest a few hints more, respecting the probable means of extending our meteorological knowledge. With this view, our first step must be *that* recommended by Mr. Kirwan and others, to establish Corresponding Societies in different parts of the World; these Societies must be furnished with similar apparatus, equally adjusted, and graduated in their construction, for making observations on the weather. In our own Island it will be necessary to procure registers, carefully kept, from the different parts of the sea-coast, and from those parts of the country situated in the interior. The various states of the barometer, thermometer, hygrometer, and electroscope, should be carefully noted; with the variations and the degrees of wind, as well as the diurnal and nocturnal aspect of the heavens discriminately marked; the appearance of the sky; and in familiar language, such as might be understood by the respective and distant observers: for instance, whether the Sun is totally or partially obscured by vapour—whether the clouds are mottled, or fleaky—whether they assume the appearance of horizontal streaks, or appear in radii apparently from a centre;—or in masses of dense vapour;—or loose and fleecy;—or those familiarly known by the name of mare-tail clouds—with any other new or accustomed phenomena. The common terms *fair*, *cloudy*, or *wet*, are insufficient for forming a judgment of the weather; as the term fair is generally at present expressed only in opposition to *rain*, without distinguishing whether the atmosphere is obscure, dull, or bright. The appearance of the stratum of air on the earth's surface, *that is the space between the clouds and the Earth*, should be always accurately described. Is there a blue haze? white mist? dense fog? or is the air transparent? which is the case when distant objects appear more than commonly distinct and near to the eye of the observer: The temperature of the Ocean at *full tide* should be frequently ascertained, as it will be found to have considerable influence in these respects on an Insular Country. By the remarks of observers, stationed in various parts of our Coasts, we should soon be enabled to discover, when vapour is wafted in from the Sea, or generated by the aqueous and vegetable surface of our Island. During a north-west wind, which is frequently attended with storms of hail and rain, and usually experienced in the Spring, an observer, stationed on the coast of Sligo, in Ireland, or Denbighshire, in Wales, might ascertain, whether the disposition of the Atmosphere to storm and cloud came in with the air from the Atlantic Ocean, or was generated by the vapours of our own Island. It would be desirable also again, that the temperature and blue hazy appearance of the Atmosphere during the north-east winds, so common in May and June, should be noticed by observers on the north-east coast, in the Counties of York, Lincoln, Essex and Kent; and by others, on the opposite western Coasts of Pembroke, Devon, and Cornwall; so as to determine what changes in temperature this wind undergoes in its passage over the Island; and whether or not the degree of haze increases or diminishes by its progress from either quarter; and whether the vapour is more or less disposed to produce storms?

By such comparative observations on the Coast, conjoined with those made by others in the central parts of the Kingdom; we might rapidly proceed in Meteorological science, or as it is commonly called a knowledge of the weather. The observations made in the interior of the country would enable us at all times to trace the origin and progress of storms; in situations where tillage or pasturage is most attended to, the effects of Spring frosts and blights should be particularly noticed, as well as the first appearance of the Aphis, and Coccus, the caterpillar and larvæ of other insects on fruit trees, and particularly those peculiar to the *hop plantations* The first opening of the Vernal foliage on trees and hedges in the Spring, should likewise be remarked, and compared with the starting up of grass on the highly-manured pastures in the neighbourhood of towns; and on those also not assisted with manure, as well as the natural herbage on the commons and wastes. Some attention should be paid to the effects of thunder storms, in destroying the Aphis and other destructive Insects, the pest of fruit and hop plantations; and the first appearance of the mildew or rust on wheat, should be particularly observed, and remarks made to ascertain, whether or not the moisture, which occasioned the disease in its commencement, was attended with wind and rain, or a close damp state of the air. The different kinds of soil, where the crops, from the disease, suffered most, should be noticed, and the situation of the land for ventilation, with the height of the fences, size of inclosures, and vicinity to coppices, trees, or hedge-rows.

The disease in question, is an increasing evil; we ought therefore to have recourse to every measure possible, to discover its true cause, that we might be able to arrest its future progress. Wheat-land highly manured, it has been remarked, generally suffers more from mildew than such as is in a more moderate state of culture, on account of the increased luxuriance of the plants, which require a drier state of the Atmosphere to absorb the perspired matter than plants of more humble growth. The great mildew, which nearly destroyed the crop of wheat in the Island of Sicily in 1804, was occasioned by moisture of the Spring, in the month of May, when the wheat was in bloom; but I must remind my readers, that the Harvest, owing to situation, is much earlier in Sicily than in England: the rains therefore, which happened in May, produced the same effect on their crops as the like weather would have done on ours in a more advanced part of the Year. The mildew, which happened in Sicily, appears to be the same disease as is known by *that name* in England; it began first in low close situations, where there was little ventilation, and gradually spread over almost every part of the Island. Deep and highly-manured lands, we are informed, suffered most; and gravelly, rocky, and other dry soils, the least; where the crop is thin, it appears to have suffered more from mildew than such as was sown thicker; which was probably owing to the increased luxuriance of those plants, least crowded together, from their roots thus acquiring more nutriment. If people could be persuaded generally to adopt the use of *Cone wheat*, it would be of vast importance, as the drier lands, and every kind of soil, except very light lands, subject to the mildew, would be likely to produce better crops than they do, when sown with the Lammas varieties. If Cone were the only wheat used for bread, and the whiter kind reserved for pastry, it would probably without any other measure, make up, on a seven years average, the deficiency of the whole quantity now imported in that period. What a national saving would this be!! The bread from cone wheat is as palatable and wholesome, if not more so, than the Lammas; and if an example were set by the higher orders of Society, perhaps fashion might introduce it into general notice.

CHAPTER XVIII.

An Enquiry into the Cause of Winds; particularly those which are experienced in Great Britain, &c.

AS Winds have a great influence on the weather, it is highly important that we should be better acquainted with their origin than we at present are. Since the time of that great philosopher, Lord Bacon, modern enquiries have thrown some light on the subject; we can now account for Winds blowing from cooler to warmer parts of the Globe; although the violent gales, which so frequently proceed from hot to cold countries, are not yet accounted for in so satisfactory a manner: the ascent of smoke in a chimney sufficiently explains the phenomenon of a wind blowing in the former instance. On this principle, the causes of the diurnal and nocturnal sea and land breezes, experienced in tropical Islands, and even on our own shores, in settled weather, become instantly obvious. Besides the occasional land and sea breezes, there is another Wind experienced in the equatorial parts of the earth, blowing almost constantly from the East; which is occasioned by the reciprocal effects of heat and cold, combined with the diurnal motion of the Earth. This Easterly current, in the West-India Islands, is liable to a diversion towards the South-east, or North-east; for instance, when the solar rays fall with greatest force on the North-American main, in May and June, Jamaica and the adjacent Islands will experience a South-east breeze; but when the land is heated most in South-America, the North-east winds are, by the same reason, more prevalent. Between these two periods they experience calms, with shifting winds, at which time the rains are frequent; the water, which had been previously taken up by the atmosphere, being returned again to the earth in torrents, attended with peculiar electrical phenomena; such as tornados, hurricanes, water-spouts, and earthquakes.

Another cause of Winds, and the most frequent one, in temperate and polar climes, is probably occasioned by *the precipitation of water from the Atmosphere.* When the water, which is evaporated from the surface of the earth or sea, appears in the state of transparent air, it may be said to be dissolved or combined with the atmosphere; and when in the state of vesicular vapour or cloud, it is not combined but floating in a state of mixture, like dust, smoke, or any other extraneous matter. Thus if sand, resin, or any other substance that is nearly insoluble in water, be mixed with that fluid, it does not add to the weight of the water, as a resisting medium; but if sugar or salt are mixed and allowed to dissolve, the hydrometer will shew a considerable increase of specific gravity: if any chemical agent be then made use of to precipitate the sugar or salt from it, the specific gravity of the water will again be reduced to what it was previous to the experiment. Now we know that water is much heavier than atmospheric air; consequently, if a portion of water is held in a state of combination or solution in air, by means of heat and the electric fluid, the gravity of the compound is increased; and when such dissolved water is precipitated again to the Earth, the Atmosphere consequently becomes lighter. If, therefore, we have a continuance of dry clear transparent weather in Summer, the barometer gradually keeps rising, owing to the portion of water which is daily dissolved, and combined by means of evaporation, proceeding from the Land and Sea. The same thing occurs in Winter, especially in frosty weather; the air being then calm, its electricity is well preserved by the coat of ice on the surface of the ground, which is an imperfect conductor; and as evaporation from the Earth is thus diminished, we have transparent days, as in Summer; and the vapour given out by the Sea, and that arising from ice and snow, being dissolved in the atmosphere, add to its gravity. Hence settled frosts are attended with a high barometer; but when a thaw commences, we are apprised of the change by a sudden fall of the Mercury, owing to the dissolved water returning to the state of cloud, or being precipitated in the form of snow or rain. The heat, which entered into combination with the water during the evaporating process, appears to exist in a latent state, as it is not discoverable by the thermometer, when the aerial compound is transparent; but when it reassumes the state of vesicular vapour, previous to its being again precipitated to the Earth, the heat is again given out, becomes perceptible to the senses, and discoverable by the thermometer: hence the warm close state of the air invariably felt during a thaw after continued frost. If the thaw and precipitation of water extends to that part of the Continent, situated to the North-east of us; for instance, in Norway, Sweden, or Russia, the diminished gravity of the atmosphere in those places causes a stream of air to pour in from the South-west; occasioning violent gales of wind in its passage over our Islands, and generally is preceded and accompanied by a *low* barometer. This instrument proves the truth of the theory, which accounts for these winds; for if the Winter gales, which we so commonly experience in this Climate in open weather, were occasioned by an accumulation of air to the South-west of us, the barometer would *rise*, not fall, during the passage of the air; as in this case it would be accumulated over our heads, instead of being drawn off.

The theory of *a precipitation of water* in one place occasioning a wind and fall of the barometer in adjacent countries, may be familiarly explained by comparing its effects to the rise and fall of water in a mill-pond*: Suppose an instrument fixed in the bottom of the pond, acting on the principle of the barometer, so as to measure the height of the impending column of water. If an additional stream of water be then supplied at the head of the pond, it would occasion a current to pass over the place where the instrument is stationed; the fluid in it will then rise; but, on the contrary, if the flood gates are opened, and the water is suffered to be drawn off, a current is again created; but this aquatic barometer would now fall, owing to the diminished gravity of the incumbent fluid, for thus the height of the impending column is lessened.

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* This corresponds with observations made in America by the ingenious Dr. Franklin.—*Vid. Franklin's Works.*

The gales of wind from the South-west, so prevalent in mild winters, may be accounted for on a similar principle; that is, from a reduction of the specific gravity of the atmosphere in the North-east, by precipitation of water: and according to the extent and rapidity will be the degree of violence, which we experience from the passage of the air, which presses in to restore the equilibrium.

This may be made familiar to observation, and confirmed by experiment thus—Supposing a considerable precipitation of aqueous matter from the atmosphere in Russia or Siberia, a ship, stationed in the Baltic, will first experience the stream of air; next the barometer will fall, and the wind regularly commence in Sweden, Denmark, and on the North-east coast of England, extending thus in a South-westerly direction, the Mercury continuing low, till the equilibrium is restored; when the storm is over in these places, it then frequently rises very suddenly; for as soon as the equilibrium is restored, the neighbouring Countries commonly experience an accumulation of air, occasioned by the motion of the stream, continuing *after the effect ceases;* from the law of moving bodies, called *vis inertiæ*, which causes them, once put in motion, to proceed in the same line for some time after the impulsive cause has ceased to act.

The stream of air experienced in England, when a precipitation of vapour happens in Russia or Siberia, is not confined to *one point* of the Compass. Thus, supposing a copious and extensive precipitation from the Atmosphere to happen in the northern parts of Russia, then will Sweden, Denmark, England, and Ireland, experience Gales of wind from the South-west; in France, South South-west; Germany, Italy, the Adriatic and Euxine Seas, it will be due South; in the neighbourhood of the Caspian Sea, South South-east; Tartary and Kamschatka, South-east and East*; and from the polar regions, due North. This hypothesis is strengthened by the circumstance of our never experiencing violent gales from the *South-west*, except in open weather; that is, we have no very high winds from the *South-west*, during a settled frost on the Continent; sometimes these Gales of wind continue for a fortnight or three weeks together, with alternate calms or gentle winds, attended by great fluctuations in the barometer; as was the case in January 1806. The continuance of these gales probably might be accounted for by the current of air, proceeding from the South-west, which, being highly charged with humidity, is frequently precipitated whenever it arrives in a colder Region, either from the change of temperature, or from a variation in its electric state: both which occasion the same sort of weather frequently to happen. But the precipitation of water from the Atmosphere may not be always at the same place; for instance, if it happen in the German Ocean, the Baltic, Norway, Sweden, or Russia, it will cause a South-westerly wind in England; but the exact point of the Compass, whence this wind will blow, will depend on the latitude and longitude of the country where the atmospheric precipitation occurs. Heavy rains in France, or the South of Germany, will occasion a fall of the barometer, and a North-west wind in England; again, a South-east gale may happen in consequence of heavy rains or snows in the northern parts of America, or the parallel parts of the Atlantic Ocean; a storm from the East, by the same rule, may arise from rains in western parallels of latitude; a storm from the North, from rains in Spain.

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* Captain Cook noticed the violent gales of wind occasionally experienced at Kamschatka, from the East and South-east.

These conjectures are founded on careful barometrical observations, but cannot be confirmed until scientific men, in different nations, agree to turn their attention to the same important point, and keep accurate registers of the weather. That the South-west and Westerly winds are so violent in this Country, is owing to the slight opposition which air meets with *in passing over the Sea, compared with that it meets with in its passage over extensive tracts of land,* where it is continually experiencing obstructions from woods or mountains; so that if a copious precipitation happen in the neighbourhood of St. Petersburgh, the current of air which in this case will proceed from the Atlantic, passing over England from the South-west, will be more violent than that which passes over Germany from the Mediterranean. These violent currents appear chiefly to be confined to the *lower stratum of air;* probably caused by its greater comparative density with that in *the higher regions of the Atmosphere.* After a fall of rain, the barometer usually rises, and would always rise, in case there was no precipitation in the vicinity to draw off a portion of air from the place of observation. This rise of the Mercury after rain is occasioned by the air flowing in from adjacent places, where the density is greater, and from the continual evaporation of water. When the air becomes heavy, from the solution of vapour, in one part of the earth, it will gravitate to the contiguous parts, to restore the equilibrium, which will cause a wind with a rising and high barometer.

Thus in a continued frost or settled dry weather on those parts of the European Continent, lying under the same parallels of latitude with England, an East wind will be the consequence; because the air is rendered heavier from the diurnal quantity of water absorbed by evaporation. Suppose by this process the barometer in the North of Germany, Holland, Prussia, and other interior parts of the Continent, to be raised, in a situation nearly level with the Sea, to thirty inches and a half; and the barometer in the same parallels of latitude in the Atlantic, to be at twenty-nine inches and a half; we should then in England experience an East wind, with a rise of the Mercury, which would probably remain at a medium height, between those countries situate to the *East* or *West*. The wind in this case is not caused by a precipitation of vapour to *leeward*, but an increased density to *windward* on the Eastern Continent. The Easterly winds experienced in England, are usually attended with a rise in the Mercury, particularly early in the Spring, considerable evaporation taking place at this Season on the Eastern Continent, by the returning influence of the Sun. The air then becomes heavier than it is in the Atlantic Ocean; consequently we experience an Easterly current, with a high barometer. The Air then increases in density, during its passage over the German Ocean and Great Britain; for we find evaporation to increase in quantity during the prevalence of these winds.

It was formerly supposed, that the high barometer, which attends an Easterly wind in this Country, was owing to a Westerly current from the Atlantic Ocean meeting an Easterly one from the European Continent, and thus causing the air to become denser by accumulation. This supposition, however, will appear, on a more minute investigation, not to be well founded; not but that two winds may, under certain circumstances, meet, and, in such a case, the Mercury will accordingly rise. When an Easterly wind happens in England, particularly if it be strong, and approaching to a storm, with a falling or low barometer; the most probable opinion is, that it is occasioned by a *precipitation of rain or snow in the Northern part of the American Continent, or on the Western Ocean.* The North easterly winds, so frequently experienced in England in May and June, which are generally accompanied with haze in the Night, and a close warmth during the Day, are probably occasioned by a continuation of the stream of air which flows in a North-easterly direction from the Northern tropic at this Season; for, in the month of May and June, Jamaica and the adjacent Islands experience a constant *South-east wind*; and this wind, between the Bermudas and the Southern part of the North-American main, becomes a North-east wind; which, by drawing off a portion of air in that direction, causes the stream to continue as far as this Country. If ever the timber should be removed, and the land put in a state of cultivation in the Northern parts of America, by which means the Country would experience more heat and dryness during Summer, it is probable this North-easterly stream may then become less frequent at this Season; in England we should then have a South-east wind in May and June, which would be an essential benefit to the Agriculture of the Country; as the air would then flow to us from France and Germany, instead of Lapland and Siberia; the North-west wind, which is so prevalent in England at particular seasons, is caused sometimes by heat, and, at others, by the precipitation of vapour in the South-east. This wind, which is most commonly felt in April and August, when it blows strong during the day, is generally succeeded by a calm at Night, and is probably occasioned by the land being heated in France, and the South of Germany, more than in England, Ireland, or the North-west part of the Atlantic: a diurnal breeze therefore sets in, which passes over England and Ireland in a *North-westerly* direction. But, when this wind continues equally high both by

Night and Day, it is occasioned by a precipitation of vapour in France and Italy, the coast of Syria, or other countries bordering on the Mediterranean; it usually happens in February and March, and sometimes continues two or three days together, with violent squalls, attended with showers of hail, rain, or snow. In addition to these causes of wind, the future researches of mankind will probably lead to the discovery that winds are generated by electrical agency, or the influence of aerial tides, both of which may occasion currents of air in the higher regions of the Atmosphere.

It is a remarkable circumstance, that the barometer *does not fluctuate in situations within the tropics, in the way that it does in the high Northern or Southern latitudes*; the usual height, at the standard level of the Ocean, in the neighbourhood of the Equator, being, according to Mr. Kirwan, twenty-nine inches and a half, and seldom varying more than a few lines; whereas in England, the variation is usually *two inches and a half*; and at St. Petersburgh, in Russia, *three inches and a half*; which may be accounted for by the comparative regularity of temperature experienced in the tropical parts of the Earth, and the great variations in this respect in countries situated nearer the Poles. Thus, for instance, on a considerable fall of rain on the

Island of Jamaica; the air, which will flow in to restore the equilibrium from the East and West, will be at the same temperature, or nearly so, as the circumambient air of the Island; and, according to Mr. Kirwan, there is little variation of temperature in ten degrees North or South of the Equator: so that whatever current of air flows in to fill the aerial vacuity, made by the precipitation of vapour, the temperature being nearly the same, there would be no sudden condensation, as in the case when airs, at *different degrees of heat*, meet each other. It is probable, therefore, that the heavy rains, in tropical Countries, are occasioned almost entirely by electrical agency. The copious evaporation from the heated Sea, in these latitudes, may likewise contribute to keep up the Atmosphere nearly at a standard weight; as the loss of gravity, from partial precipitation, would be so soon repaired by the quantity of water daily evaporated from the Ocean. During heavy rains, attended with calms in July, we find the barometer in England little affected, and, in the Summer months, it is very unusual to see the Mercury lower, *than twenty-nine inches.*

Aqueous surface yields most vapour, when its temperature is higher than that of air, and the evaporating power appears at its minimum, when both are nearly at the same temperature, Thus, in the Autumn, towards the end of October, or in November, we have in England usually frosty weather, from the heat the Sea has acquired during the previous Summer, and the air being at this time cooled lower than the temperature of the Sea; but, towards the end of February, and in the month of March, when the temperature of the Sea has been lowered by the cold of Winter, and the Atmosphere begins again to be warmed by the returning influence of the Sun, the temperature of each becomes nearly equal; consequently, at this Season, we generally experience a drier and clearer sky than in November and December. Towards the middle of April and May, the luxuriant vegetable surface in England begins to raise such a quantity of vapour, as to obscure the Sun during the Day, and produce a great degree of cold at Night. In the middle of the Day, for an hour or two perhaps, the vapour is dissipated; it then becomes very hot, and this irregularity of the weather is productive of the many diseases, &c. as already described, incidental to vegetable and animal life. Before the vegetable surface is fully expanded, which is the case frequently in the month of April, we have a North-west Wind during the day, the Earth being then heated in France and Germany. This Wind, some Years, is again prevalent in August, the crops, at this Season, having been removed on the Continent to the South-east, they, in consequence, experience an increase of heat, when the North-westerly current again sets in, over England and Ireland.

According to a Meteorological Register, kept by Major Rook for sixteen years, that is, from 1785 to 1800 inclusive, the most frequent Winds in England blew from the *South-west* and *North-west*; and, during the last eight years of this period, the South-west Winds have been more prevalent, and those from other quarters have been less so; while the average number of days in which the North-east Wind has prevailed, appears to have been much the same, during both periods. The cause of this variation probably arises from the changes which take place on the surface of the European and American Continents. America, it is stated, experiences less rigid Winters now than it did a century ago; and those best acquainted with the subject assert, that the Winters in England and Ireland have, for some years past, been generally much milder: but, from the insular situation of these Islands, they must ever have experienced a less variation of temperature than countries under the same parallel of latitude, even previous to the introduction of our Agricultural improvements.

The question, whether or not mild or severe Winters are most favourable to animal and vegetable life in this Country, has occasioned some diversity of opinion; the bills of mortality are a strong evidence against the admirers of continued frosts; and the winters of 1794 and 1795 have proved, that neither the Agriculture nor Pasturage in this Climate, are benefitted by *severe* Winters; for, in the Spring of 1795, the mortality amongst the sheep and lambs, from cold and scarcity of food, was very great, and the deficiency of the wheat crop, the ensuing harvest, was such as had not been experienced for several Years before. Moderate frosts, such as we commonly experience in the generality of our Seasons, seem beneficial to our Winter and Spring crops; but long-continued and severe frosts prove perfectly the reverse. Snows are of essential service to arable lands, by preserving the crops from cutting Winds, and preventing the intense cold from penetrating far into the ground. As the snow dissolves, the earth absorbs it, and it consequently contributes to future fertility in two ways; first, by furnishing oxygen air to the soil, which may exist in combination with the water; for we find that water, procured from melted snow, contains a large quantity of this kind of air, in a latent state, which will be evident either by boiling the water, or by exhausting the aeriform matter under the receiver of an Air-pump. When the water, which proceeds from the dissolution of snow, penetrates the earth; its temperature is at thirty-two; so that the radical fibres of vegetables are cooled, which increases the living principle or excitability of the plant, and induces greater vigour when the genial warmth of Spring and Summer returns; hence the adage, "If the grass grows in January, it will not grow in June." Modern Chemistry has exploded the absurd idea of *Nitre* being contained in snow. The fertility occasioned by the introduction of air into the interior of the soil from snow water, and the salutary coolness given to the roots, are reasons sufficient to explain, why snow fertilizes the land on which it falls. The most likely time for finding Nitre in any soil would be in the Autumn, after there had been a considerable time of previous drought. If the dust of roads, or the Soil of fallow lands, which have been enriched with manure, especially, were lixiviated in such a Season, the weather dry and bright, it is highly probable that we should find it impregnated with a considerable portion of nitrous salts. Nitre is found naturally formed in Spain, Egypt, and China, and if it were not for the frequent rains we experience in this Country, it is probable our manured lands would afford a considerable portion of this Salt.

The greatest desiderata, and what the Agriculture of England would be most benefited by is, the removal of the unsalutary influence of the *cold North-east Winds*, *blue Mists*, *Frosts*, and those *irregular Heats*, so prevalent in the months of April, May, and June; and the too frequent *Rains* which happen during the bloom and filling of the wheat in July and August. If we ever succeed in remedying these inconveniences, either by a more judicious management of the Vegetable Surface, or by Artificial Electrical Agency, the Climate of England, if it could not vie with, might at least be equal, with its other advantages, to the most admired on the Globe.

CHAPTER XIX.

Effects of Electrical Agency—A Recommendation of a Plan of occasionally Electrising the Atmosphere, as well as occasionally dissipating its Electricity, &c.

IT has before been mentioned, that the learned *Beccaria* found, in the South of Europe, that a clear transparent Atmosphere was almost always positively electrified; the same has been observed by electricians in this Country, when the weather has been clear in Summer, as well as frosty in Winter. The electric matter seems, at these times, to be regularly diffused through the whole Atmosphere; and, by keeping the particles of vapour asunder, to preserve them in a state of solution. The Electricity, in this state of the air, is not perceptible to our ordinary senses; it is only when partial accumulations happen that thunder storms arise. The great cause of our clouded Atmosphere, and frequent storms of thunder, in Summer, arises from the exhaled vapour being partially deprived of its Electricity by the great number of conductors which exist in the form of points, on *marginal Extremities of leaves, the bearded ears of corn,* and *various other appendages which serve to constitute the organization and attire of the vegetable world.* These are incessantly detaching a portion of electric matter from the circumambient air, whenever it is charged in a higher degree than the Earth.

To make this evident, only bring an electroscope within a small distance of trees or hedges, whenever the air happens to be highly electrified during a negative state of the lower Atmosphere; for vegetables emit a quantity of electric matter to the air, which when near, the electroscope proves. In fact, these numerous conductors are perpetually tending to preserve an equilibrium between the electrical state of the Atmosphere and the Earth. This conducting power of vegetables is very pleasingly seen during a frost, especially if attended with what is termed Rime. The terminating points of vegetables are then beautifully covered with crystals; that is, particles of water attracted together, and thus fixed by the conducting power of vegetable matter.

The vapour exhaled from the Sea is not so liable to be deprived of its Electricity, as that which arises from luxuriant vegetables; owing to the smooth and even surface, which the Ocean presents to the Atmosphere, especially in calm weather. Hence frequently the sky is clear at Sea, when the Land is inveloped with cloud; as often occurs during the Summer season in the British Channel, on the south-coast of England. To illustrate this point further, we will suppose that every particle of vapour, arising either from the Sea, or from a level surface of the Earth, as sand, &c. to be charged with a certain proportion of electric matter, which we will, for the sake of comparative calculation, call *two;* and that each particle, which issues from the under leaves of luxuriant grass, corn, or woodland, be denominated *one*; these particles, by currents of air coalescing, or coming within the sphere of each other's electrical influence, are not repelled, but are attracted, and produce the coalescence. This may be illustrated by the following experiment: Suspend from the wires of two deep jars, with hempen thread to each, a small pith ball, a little moistened with water; let the jars be then charged with the positive Electricity; if these pith balls are so placed as to be near together, they will mutually repel each other, the Electricity being of the same intensity. Separate the jars, and bring a pointed wire to any part communicating with the internal coating of one of them, so as to draw off a *portion* of the charge, but not the *whole*; bring the jars, with their suspended pith balls, again near to each other, and they will be mutually *attracted*, the balls will coalesce and adhere together, from the cohesive attraction caused by the moisture. This experiment is illustrative of the atmospheric process, when vaporous particles of different degrees of density happen to meet in the sphere of reciprocal influence: and this is the general cause of rain, hail, or snow. The increase of intensity, when several particles of vapour unite, has already been explained, and is caused by the surface not being increased from the union of the particles in proportion to the bulk. When vapour floats over our heads, as in a cloudy day without rain, the particles are all of the same intensity with respect to their proportion of electric matter, and therefore mutually repel each other; like so many pith balls in electrical experiments. The rays of the Sun in Summer are constantly counteracting the formation of clouds, when the electricity is strong, which, for that time, continues pretty equal; as is evident by observing the small detached particles of vapour, and the enlightened edges of large clouds, as before observed. When the floating vaporous particles come within the attracting distance of the lower, or shaded part of the cloud in larger quantities than the Sun can dissipate, storms ensue, accompanied with lightning and thunder. A *fog* is occasioned by the formation of cloud in the lowest stratum of air on the Earth's surface, and is generally positively electrified; especially if the fog should be very dense, and unaccompanied by wind. Such strongly-electrized fogs are commonly dissolved into transparent air by ten or eleven o'clock in the morning, at Seasons when the sun has considerable elevation, as in Summer and Autumn; which evinces the disposition vapour has to change into transparent air, when strongly and uniformly electrized in a positive manner. These fogs sometimes turn to rain, though not frequently; and when it does occur, it is occasioned by vapour of a different temperature, or state of Electricity, formed in a higher stratum of air, combining with vapour of the lower stratum: and thus, by combination, forming rain. Might not, then, the blue, hazy, indolent Atmosphere, so frequently experienced in England in the Spring and Summer months, and which is such an hinderance to vegetation, and so productive of blights, be disposed to disperse into clear transparent air, by artificial means? as, for instance, charging it with a larger quantity of positive electricity? In this state of the Atmosphere, I feel persuaded, and experiments, the results of which have been uniform, support the idea, that Art might be made use of to superinduce an additional portion of electric matter into the lower stratum of air, and thus promote the tendency of vapour to precipitation or dissolution.

Two revolutions of an excited electrical machine, which may be performed in two seconds of time, will electrize the air of a room twenty-four feet long, by eighteen feet wide, and thirteen high, as strongly as ever I have found fog electrified in the month of September; provided a lamp or candle be placed on the insulated conductor, so as to diffuse the electric matter: and this electricity is not wholly reabsorbed by the walls, floor, or ceiling of the room, in less time afterwards *than one-fourth of an hour.*

Suppose, therefore, a building erected and furnished with machinery, something similar to a cotton or silk mill, and that the various movements consisted of cylinders or plates of glass, fitted up with rubbers, &c. for exciting electricity; and so arranged as to convey the electric matter into an insulated upright bar, terminating without the roof of the building, in a large lamp or a series of lamps and points for again diffusing the electrical matter in the circumambient air? I find, by calculation, that a force adequate to work a common pair of millstones, would give motion to twelve hundred such electrical cylinders or plates of glass. If, therefore, one cylinder, in two seconds of time, will electrize so many cubic feet of air contained in a room twenty-four feet by eighteen, and thirteen feet high; it might be easy to calculate what quantity of vapour for any given space and height, expanse being also attended to, in any given time: the number and power of such apparatus being previously ascertained. A calculation might thus be formed to decide what number of machines would be adequate to electrize the whole Atmosphere of Great Britain one mile in height; for it does not appear that dense vapours ascend much higher than this in our Climate; and the dry state of the transparent air would preserve the insulation: so that the Electricity thus given to the Atmosphere, would not diffuse its influence far above the *vaporous Regions.* Might not one or two buildings, of the nature I have described, furnished with the requisite apparatus in each County, be adequate to effect all we want, so as to render the Seasons more propitious to the health of our growing crops. If ever an experiment should be tried, the building ought to be erected on a heath, or at least in a situation devoid both of trees and buildings; as these would reabsorb the electric matter: elevated land, but not mountainous, would be the most eligible. Such powerful machines as I have described, might perhaps occasion local accumulations of electric matter, and thus excite frequent thunder storms; if so, a greater number of smaller exciting instruments might be applied in different parts of the Country. The pendulums of our clocks, for instance, might be made to furnish electrical matter to pointed insulated wires, communicating with the outward air, the Electricity being generated by approximating metallic plates in the way, that experiments have been performed by Bennet, Volta, Cavallo, and other ingenious Philosophers.

Could we succeed in dissipating vapour, a process the reverse of this, but equally beneficial, would enable us to divert the existing electricity in the Atmosphere during Seasons of unusual drought, so as to precipitate the aqueous particles at our pleasure. I have alluded to Thunder Storms, which might, in some cases, be occasioned by the machinery described; but it is more probable we shall possess the means of preventing them, if requisite; as the lamps and points, terminating the large conductors, might be appropriated to the purpose of draining off the electric matter from overcharged clouds, and causing it to descend gradually to the Earth by an oblique communication with the lower part of the conductor, adapted for *such occasional necessity.*

If ever these ideas (and I wish here to be understood, that they are thrown out *as suggestions to excite the attention of others more adequate to this important subject than myself)* should be realized, it would require a previous extension of our Meteorological knowledge. A Board of this kind should be united with other Agricultural Establishments for conducting the process; and the machinery should be made to act simultaneously, and under telegraphic signals; otherwise one county would be counteracting another; and no attempt should be made to effect a change in the weather, except in those instances, where there can be no doubt of the efficacy of such change, whether it should be for fair or rain. It might not be desirable to have recourse to Art at all times; but only when the weather is in *that extreme*, which is universally considered unfavourable to animal and vegetable life. Thus if, in the Spring-season, by keeping the air strongly electrified, we might perhaps be able to prevent the deleterious effects to our fruits and vegetables, arising from ungenial weather in April and May.

The frost, that is the descent of the cold air in calm Nights, would happen the same; but the embryo fruit would perhaps be preserved by the stimulus of Electricity, substituted as a succedaneum in the absence of heat. In a dry state of the air, we often find a frost in these Months very severe, when the air is highly electrified; and this appears to be the reason that our fruit trees are not injured; but if a frost happens when there has been rain the Evening before, and the moist state of the air renders it so powerful a conductor that no Electricity is perceptible, it scarcely then ever fails to produce such a frost as to destroy our crops. Hence close, moist, and low situations, suffer more on such occasions from Spring frosts than ground moderately elevated: the cold, it is true, is not greater in low situations, in a calm Night, than those more elevated; but the absence of Electrical influence appears to be an additional cause why such situations especially, if closely surrounded with plantations, suffer most from its effects. According to the most accurate experiments, the presence of electric matter promotes the growth of vegetables, and is conducive to the evaporation of water. Seeds are found to germinate much quicker, if constantly electrified, in comparison with other seeds of the same kind, kept under similar circumstances with respect to heat and moisture, but destitute of this influence.—*(Vid. Phytologia, p.* 311.*)* It is an old and generally-received maxim amongst gardeners, that thunder hastens the filling of the pods of peas; and storms of thunder and lightning doubtless prevent fruit and hop-plantations from the depredations of the Aphis, and relieves them when attacked by these destructive Insects. Nor is it improbable, if we could keep the air constantly electrified, during the filling and ripening of wheat, that it would entirely escape either the disease of blight, smut, or mildew; the ears of barley and cone-wheat are armed with an awn or beard, and therefore, it has been observed, are not so liable to be injured by either of these as Lammas-wheat. May this not be owing to the greater portion of electric matter, mutually given and received by the vegetative process in this kind of grain? Both these give and receive Artificial Electricity rapidly, as may be easily perceived by placing the bearded ears of corn on the charged conductor of an electrical machine, and others on the cap of an electroscope; the influence on the gold leaf will be as quick, or nearly so, as if two candles had been used, and will be sensibly affected at twelve or fifteen feet distance. The branches of the Fir and Pine, from their finely-divided leaves, presenting a large surface of marginal and other points to the air, become very powerful conductors of electric matter. Those whose habitats are principally in high Northern latitudes, are enabled by their resinous juices to resist the rigours of Winter, and constantly to retain their foliage; as in North America, Norway, Sweden, Russia, Scotland, and the North of Germany. The organization of this class of vegetables, so peculiarly adapted to the various inconveniences arising from Climate in higher latitudes, points out a wise design, that has hitherto escaped observation. The retention of the leaves by the Pine and Fir tribe, with the exception of the Larch, during the Winter Season, seems intended to answer a most important purpose; that of drawing off a portion of electric matter from the Atmosphere; and thus preventing the great dryness and cold, which would otherwise be prevalent in seasons of severe frost. There is a sufficient quantity of aqueous matter combined with the resinous in these trees, to give them the power of conducting Electricity; and the construction of their leaves, as we previously observed, is admirably adapted for this purpose. At the same time the violent winds, which these trees are necessarily exposed to, experience little obstruction, as the air is enabled readily to pass the interstices of the leaves; but, lest the resistance should be too great for the trunk to bear, they are endued with a much greater degree of flexibility than deciduous trees, as the Oak, Chestnut, &c. If the Pine and Fir tribes had been furnished with leaves of the breadth of the Oak, Chestnut, or Laurel, the conducting surface would not have been greater; if so great, as it is by the present minute division of the leaves: at the same time if they had been patulous, the force of the Wind in Winter must inevitably have broken their trunks, or torn up the trees by the roots.

The great importance of snow in high Northern latitudes, to preserve the internal warmth of the Earth, has been universally admitted; and plants, which have been removed from those into lower ones have perished for want of this protection. An instance of this kind occurred at Upsal, in Sweden, some years since. *(Darwin.)* We know, from experience, that evaporation takes place even in ice and snow. The process is much slower than from water; therefore in countries subject to settled frosts, as Russia, North America, &c. the Atmosphere would be so strongly charged with Electricity in Winter, as to preserve a constant transparency in the air, which would be liable to absorb the snow by means of evaporation; and thus expose the surface of the earth to the utmost rigour of severe frosts. One cause why electric matter becomes so plentifully diffused in the Atmosphere in frosty weather, is the dry state of the air preserving the insulation better, and the crust of ice on the surface of the ground being a very imperfect conductor; so that a very small portion of this fluid is at this time drawn off, except by means of trees.

Forests of Pine in Europe extend as far South in Germany as Vienna, and even to the shores and Islands of the Mediterranean; though they are not met with there so frequently, and in such abundance, as in countries to the North. The winters are very severe in those parts of Germany, which are at a distance from the Sea; it is necessary, therefore, that much snow should fall, to preserve the genial temperature of the ground: accordingly we find not only the pine very prevalent in the remains of the ancient forests in Germany, but also the Oak and Beach. In fact these forests consist almost entirely of such trees; the latter, it is true, are not evergreens, but then they retain a portion of their withered leaves the greater part of the Winter, long after they cease to be useful in preparing the necessary juices. Why should such trees thus retain their leaves, if, by such retention, some beneficial purposes were not to be answered? The leaves of the Elm, Plane, Chestnut, Acacia, &c. that are natives of milder Climes, shed ther leaves as soon as they cease to be useful in the process previously alluded to.

From experiments I find, that a winter branch of Oak or Beach, which has not been deprived of its withered leaves, will conduct, that is draw off, from an electricised Atmosphere, a much larger portion of electric matter, than such branches would do, when they have been deprived of their leaves; and as these trees are principally met with in latitudes where the rigour of winter makes it necessary for the preservation of animal and vegetable life, that a great quantity of snow should be precipitated; we may conjecture, if not conclude, that the extensive conducting surface, obtained by the retention of the foliage, during the winter, is intended, by an omniscient Providence, to answer some great and beneficial design: and, amongst others, the one here suggested does not appear the least important. The power of Electricity, in influencing the growth of vegetables, occasioning currents of air, superinducing changes in the Atmosphere, and regulating the state of the weather, is at present but little understood; the study of this department of science holds out the probability however of a vast accession to the present stores of human knowledge; and, it is to be hoped, will soon excite the pointed attention, and stimulate the exertions, of Philosophers in this enlightened age: so that, at no very distant period, we may possibly be able, not only to prevent sudden changes, but check violent extremes in the weather, and render the cold, humid, and fickle Climate of Britain equal, if not superior, in salubrity and fertility, to many Countries at present enviable for their settled Atmosphere and unclouded Skies.

It has already been remarked, in the course of this humble attempt to draw the attention of Physiologists to the study of Meteorology, that the changes effected on the surface of the Earth by the improvements in Agriculture, have hitherto produced only an *accidental* influence on the weather. When men directly attempt an amelioration of the Climate by any of the means here suggested, or by others which hereafter may be offered, it will form a new and highly important Æra in the various branches of Agricultural and Rural Economy, and in those Arts and Sciences, which are intimately connected with the prevention of Disease, and the preservation of Life.

THE END.

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